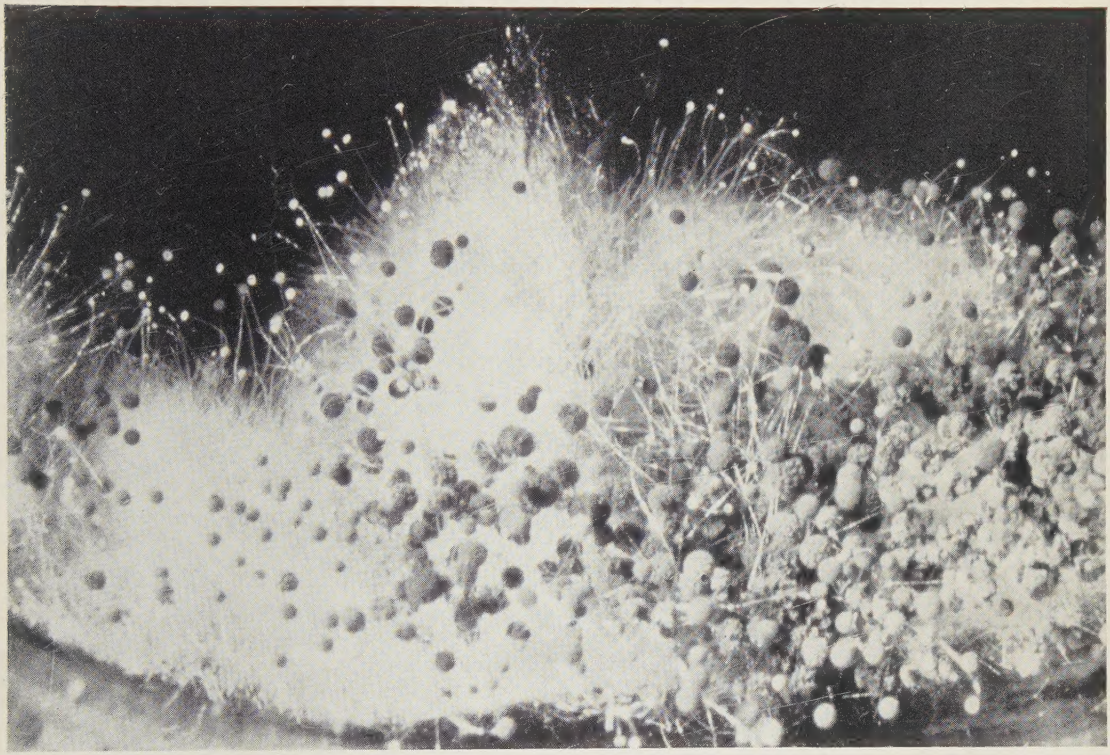
NOPITSCH, M. 1953

Ciba Review 100



A colony of *Aspergillus niger* on sumach tanning liquor as seen with a low power of the microscope (× 30). This mould forms special spore-bearing structures with dark brown to black, globose heads containing millions of asexual reproductive spores. *Aspergillus niger* is a destructive contaminant not only on tanning liquors but also on a wide variety of organic materials. Photo: Research Laboratories, Ciba Limited.

Micro-organic Attack on Textiles and Leather

New! *Fungicide G Paste*

A highly effective preservative for the *textile*, *paper*, and *leather* industries

Textile industry	Preserving sizes and finishing mixes for yarns and fabrics Preserving unfinished or finished textiles Preserving printing pastes Preserving proofings
Paper industry	Preserving the «stuff» Preserving finishing agents which are to be added to the pulp Preserving glue for board
Leather industry	Preservative to be used in soaking, liming and fatliquoring Preserving chrome or vegetable tanned leather Preserving vegetable tanning liquors Preserving seasoning and finish liquors
General uses	Disinfectant for floors, walls, etc., in factories Algae preventative for water

Ciba Review 100

Basle · October 1953

Micro-organic Attack on Textiles and Leather

By M. Nopitsch, Clothing Physiological Research Institute, Schloss Hohenstein, Germany

The Discovery of the Microbes . . . . . page 3582

Microbial Deterioration of Wool and Other Animal Fibres . „ 3585

Microbial Damage to Vegetable Fibres . . . . . „ 3590

Decay of Fishing Nets through Microbiological Action . . . „ 3597

Micro-organic Attack on Leather . . . . . „ 3600

Identification of Microbial Damage, and Culture Methods . „ 3604

Preventive Treatments for Textiles and Leather . . . . . „ 3610

Modern Trends in Printing, Dyeing, and Finishing

Fungicides and Bactericides for the Leather Industry . . . . page 3617

Fungicide G Paste in the Textile and Paper Industries . . . „ 3619

Marking off in Printing. . . . . „ 3620

New Ciba Dyes and Textile Chemicals . . . . . „ 3620

Reprint and Translation, whole or in part,
are subject to the permission of the publishers of Ciba Review

The Discovery of the Microbes

In the unceasing changes in nature from life to death the smallest of living beings, known as micro-organisms or microbes, play an essential part which is often all but overlooked. Whereas protozoa, the lowest forms of animal life, normally develop in water or damp soil, bacteria and microscopic fungi, which belong in the plant kingdom, also people the atmosphere. Occurring by the myriads, they are the principal agents in many constructive and destructive processes of life. One gramme of soil contains from 100,000 to a hundred million germs, and in a gramme of cow dung their number may be up to 40 milliards. Man ingests micro-organisms with food and water, destroying or excreting the harmful germs provided his powers of resistance are not impaired. Bacteria would seem to be essential to digestion as they occur in large numbers in the gut of healthy humans.

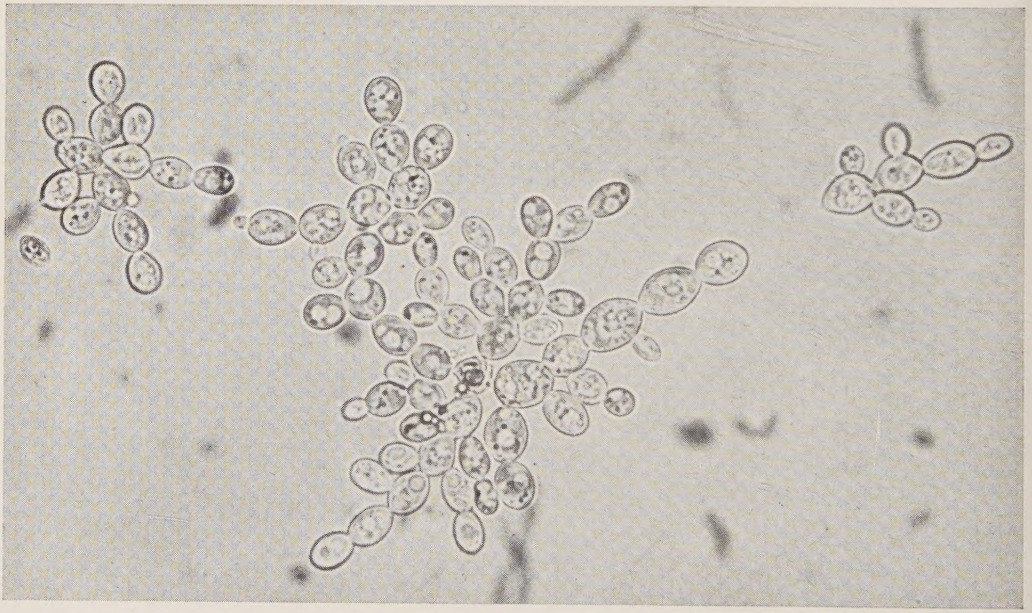
As in nature, the activities of micro-organisms are of great importance in industry. They may initiate, promote, or inhibit certain processes. Microbiological processes enter into the production of wine, beer, and vinegar, the souring of milk, the ripening of cheese, the baking of bread, the tanning of leather, the retting of textile fibres such as flax and hemp, and the curing of tobacco.

Under favourable conditions, large aggregations or colonies of micro-organisms are formed. Unlike individual organisms, which can only be detected by means of the microscope, such colonies, when present on infected materials, are in most cases visible to the unaided eye. The wide field of microbiology is concerned with the morphology and behaviour of micro-organisms, their relationships with other forms of life, and the study of their multifarious chemical actions, which are of especial interest to industry.

Micro-organisms were first demonstrated by Antony van Leeuwenhoek (1632–1723). Examining a drop of water through his microscopes, which he first built himself as a hobby, he observed a vast number of mobile living beings. He made the first drawings of these "animalcules" and found similar organisms in various vegetable infusions, in rotting meat, and in the white film on his teeth.

Until 1854, natural scientists endeavoured, in the main, to establish a system of micro-

Brewer's yeast belongs to a group of non-pathogenic fungi used as agents of fermentation. It is grown as pure-culture yeast from a single cell. Photomicrograph, taken at the Swiss Breweries' Research Centre, Zürich.



Mycelia and spore-bearing organs of mould fungi as found by Davis and Dreyfus in cotton fabrics. Specimens from a collection of 27 genera described in their work "Sizing and Mildew in Cotton Goods", 1889.

organisms almost wholly based on a study of morphology. According to the views of the pleomorphists, whose principal exponent was the Swiss natural scientist Karl Wilhelm Nägeli (1817–91), micro-organisms formed no permanent species of distinct morphology. In contrast, the monomorphists headed by Ferdinand Cohn (1828–98) considered the morphological and physiological characters of microbes to be constant. The latter view has since been superannuated by the discovery of the phenomenon of microbic dissociation or variability.

The immemorial controversy over "spontaneous generation" of living beings, independently of parent organisms, from inorganic or organic matter was rekindled by the discovery of the microbes. No less a person than Louis Pasteur (1822–95) finally exploded the doctrine by showing that even bacteria and fungi take their origin from spores. He was the first to use both the "sterilizing" process which by means of very high temperatures renders utensils and liquids germ-free, and filtration through porous bodies which hold back the micro-organisms. Pasteur also discovered the use of cotton-wool plugs for preventing the infection of tube cultures. He likewise found that a narrow bent glass tube, though admitting air into a vessel containing a culture, protects it from contamination because the airborne dust particles and the microbial spores attached to them are deposited on the wall of the tube.

Pasteur's studies in fermentation laid the foundations of modern bacteriology and sterilizing technique. He found that every type of fermentation is caused by a specific organism, yeasts accounting for alcoholic, and certain bacteria for lactic acid, fermentation. Pasteur showed that butyric acid, one of the products of acetic acid fermentation, is due to a bacillus, Clostridium butyricum.

As fermentation usually takes place in the absence of air, bacteria and yeasts derive the oxygen needed for their development from the compounds they ferment. According to Pasteur, fermentation is "merely life without air, or rather the result of life without free oxygen". These remarkable findings enabled him to carry out a number of very important improvements in the fermentation industries. For the control of bacteria responsible for the clouding of wine he suggested the heat treatment since known as "pasteurization". Pasteur's later investigations were concerned with bacteria pathogenic to man and animals, a field in which Robert Koch (1843–1910) was to become the leading figure.

The discovery and methods of control of micro-organisms harmful to textiles were not attended by such spectacular events; they were, in fact, arrived at only gradually and from very modest beginnings. According to Georgiewics, it was W. Kalmann who first demonstrated the bacterial origin of a disease peculiar to the wool fibre. Rotting develops in a damp condition on wool yarns and fabrics which are stored in hot and poorly ventilated rooms, especially in the presence of alkali. It often used to be noticed on indigo-dyed fabrics where it showed as light spots.

At a very early date it was also realized that clean cotton is practically immune to bacterial

and mould attack while finished cotton goods when stored in basements, damp lofts, and such-like places tend to become spotted. These stains, which range from yellowish to olive green or from brown to nearly black, were known as spore stains or mouldy spots. J. Dépierre, a French textile expert, was the first to study mould growth on finished cotton, and described them in his "Traité élémentaire des apprêts des tissus de coton". As early as 1889, Davis and Dreyfus gave a detailed account of 27 genera of moulds responsible for staining and deterioration of cotton fabrics (see page 3583).

In England, the Textile Institute of Manchester, which was founded in 1919, published numerous papers on mould formation in, and bacterial damage to, textiles, the growth conditions of mildewing receiving particular attention. To-day, there are research centres in nearly every country, investigating the entire field of microbiological attack on textiles and developing ever better means of control.

M. Nopitsch

Very small amounts of

Fungicide WK high conc.

control bacterial contamination of soaking and liming liquors

Raw hides and finished leather, tanning liquors, seasonings, and pigment finishes are fully protected against mildew attack by

Fungicide G Paste

Fungicide L

prevents microbial growth on heavily greased sports and service leathers

Fungicide L is readily soluble in oils and fats

Eminently suitable as an addition to leather soaps, etc.

Microbial Deterioration of Wool and Other Animal Fibres

In tropical and subtropical countries and under warm storage conditions in ships, wool clothing has been observed to develop signs of deterioration—often rapid and of considerable extent—the cause of which was not understood at first. Similar damage occurred in scouring raw wool or when allowing insufficiently rinsed and de-watered wool goods to lie after treatment in alkaline baths. Steaming of wound wool yarns may also produce damage if the yarns contain alkaline lubricants. Degradation of a kindred nature is frequently seen in papermakers' felts, which are used for conveying the wet pulp.

Woollen wear for infants and woollen swim suits are also liable to deteriorate in this way. Bleaching faults in wool goods not traceable to incorrect treatment or metal catalysis must be classed here, too.

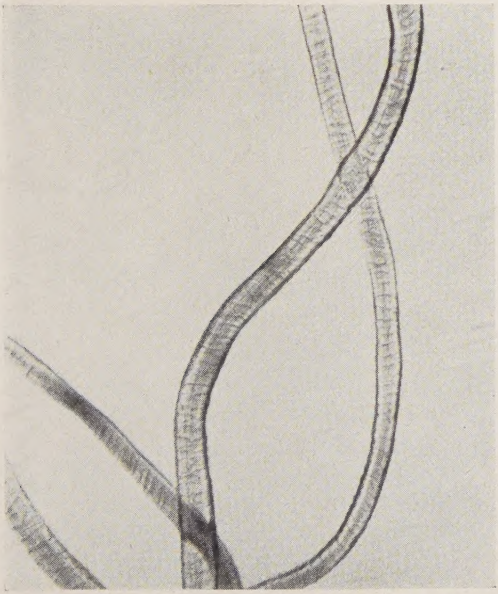
Microbiological culture tests carried out with such damaged textiles showed the cause of the various phenomena to be rod-shaped bacteria. These belong to a widely distributed class of saprophytic organisms responsible for the breakdown of animal proteins, and form part of Thallophyta, the lowest group in the plant kingdom (without true roots or shoots).

This group comprises the unicellular bacteria and yeasts, and the many-celled moulds and higher fungi. As they contain no chlorophyll, unlike the higher plants, they depend on a saprophytic or parasitic mode of life. The Thallophyta are subdivided into bacteria or fission fungi (Schizomycetes) and filamentous fungi or Fungi Imperfecti (Hyphomycetes). The table on page 3586 lists the true bacteria or Eubacteriales. Saprophytic bacteria grow on dead or decaying organic matter while the parasitic organisms, that is most pathogenic bacteria, require a host to which they are adapted in varying degree.

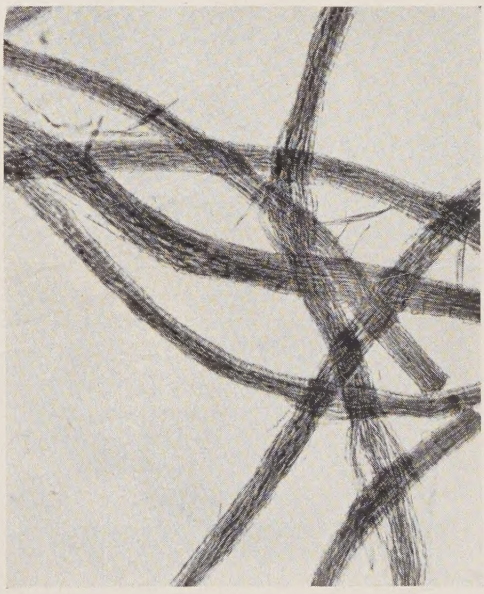
The bacteria which attack wool are mainly spore-forming species belonging in the group of the so-called soil bacteria. Being aerobic they require elementary oxygen (cf. page 3589). Of the anaerobic bacteria, Bacillus putrificus, a putrefactive agent as the name implies, is destructive to wool and other animal fibres.

Occasionally, pathogenic bacteria which give rise to pus and liquefy gelatine may cause damage to wool, e.g. Pseudomonas aeruginosa and Micrococcus pyogenes (also known as Staphylococcus on account of the grape-like clusters formed by the organisms).

Chrome-dyed merino wool, undamaged after two months' exposure to Bacillus mesentericus. Magnification × 150. Photo: M. Nopitsch.



Bacterial deterioration of wool in the first stages of fibre disintegration. Lactophenol cotton blue preparation. Magnification × 150. Photo: M. Nopitsch.



Heavy bacterial attack on sheep's wool, which has resulted in separation of the spindle-shaped cells. Lactophenol cotton blue preparation. ×150. Photo: M. Nopitsch.

Sheep's wool extensively damaged by bacteria. Lactophenol cotton blue preparation. Magnification ×150. Photo: M. Nopitsch.

Most investigators of wool destroying bacteria have worked with Bacillus mesentericus and Bacillus subtilis, as pure cultures are fairly readily obtained with these two species.

The spores of bacteria, especially of those living in the soil, spread everywhere, the essential conditions for their growth being high moisture content, relatively high temperatures, and an optimal pH value in the alkaline region. Bacteria are introduced with the raw wool, on earth-clogged footwear, or with dust, which is apt to contaminate the entire factory unless the premises are kept reasonably clean. According to the recent literature, the minimum moisture content of wool necessary for the development of bacterial attack is 40 per cent and the minimum temperatures are said to range between 25 and

Eubacteriales (True Bacteria)

Name	Shape	Size	Spores	Motility
Spherical bacteria or cocci (Coccaceae*)	spherical to oval	1–2 μ	none	absent
Rod-shaped bacteria:				
(a) Bacillaceae	rod-like	0.5–2.5 μ × 1.5–15 μ	yes	yes
(b) Bacteriaceae	rod-like	0.5–0.8 μ × 1.0–5 μ	none	mainly absent
Spirillaceae:				
(a) Vibriones	short, curved rods	0.3–0.5 μ × 2–4 μ	none	yes
(b) Spirilla	cells with one to several corkscrew twists	1–3 μ × 5–30 μ	none	yes

* Described as Micrococci, Diplococci, Tetracocci, Streptococci, and Sarcinae, depending on the grouping of individual organisms

40° C. (77 and 104° F.). Slight alkalinity of about 8 to 8.5 pH is regarded as the best reaction. Below neutral (pH 7.0), bacterial activity is much reduced.

For its food supply, the bacterial cell, which is surrounded by a watery envelope, depends on water-soluble products absorbed via its semi-permeable cell wall. To obtain these, the cell secretes enzymes into the surrounding solution so as to break down the insoluble materials to be assimilated. Thus, proteins are converted by proteolytic enzymes.

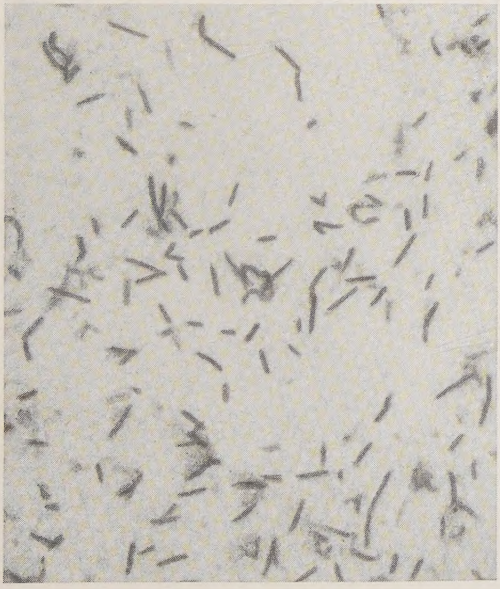
Bacteria are about 1–5 microns long and 0.5–1.0 micron in diameter (1 micron = $\frac{1}{1000}$ millimetre). Propagation is chiefly by asexual fragmentation. Certain species such as Bacterium vulgare and Bacillus subtilis are capable of movement by means of lash-like appendages termed flagella. All Bacillaceae form highly resistant resting spores which, as for instance those of Bacillus mesentericus, withstand half an hour's heating in a water bath without losing their viability. This is in marked contrast with the spores of all mould fungi.

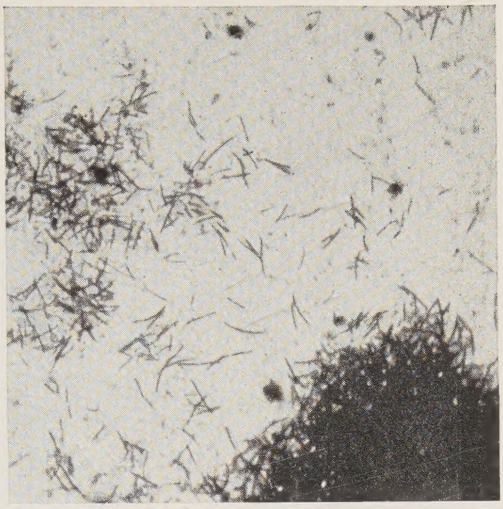
The wool fibre is known to consist of the following layers:

1. the external layer of overlapping scales (epidermicula) which often envelops the entire fibre;

2. a thin cuticle, the subepidermicula (Reumuth's subcutis);

Bacillus megatherium. ×900. *Photo: M. Nopitsch.*





Bacillus subtilis colony. Marginal zone. ×400. *Photo: M. Nopitsch.*

3. the cortex, made up of a large number of spindle-shaped cells bound together by a cement, the intercellular matrix;

4. in "hairy" fibres and kemps, the inner central core or medulla of short cylindrical cells. The true wool fibres do not as a rule contain a central core. Occasionally, the medulla, instead of forming one continuous strand, is composed of a hollow network.

In bacterial attack, the enzymes digest only the amorphous substance occurring in the scales of the wool fibre; as the matrix between the cortical cells; and partly also within the cortical cells. Disintegration of the wool fibre results from isolation of the spindle and scale cells. In practice, wool fabrics have been found to vary widely in their susceptibility to bacterial degradation (cf. page 3610).

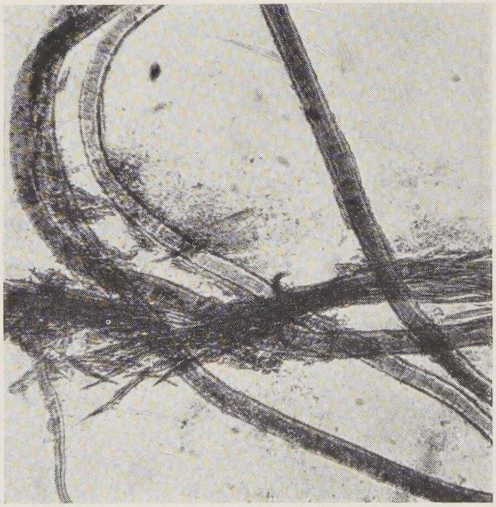
Unlike the results of mildew attack, bacterial damage of wool is often difficult to recognize with the unaided eye. In many cases, the only indication of infection in fully finished and dyed fabrics consists in scattered or extensive areas of tendering and signs of premature wear. The exact cause has to be traced by means of culture tests (cf. page 3604). In grey fabrics whose wool fibres have not yet been destroyed, the finishing processes need not necessarily cause holes or large-scale damage, but deterioration shows up clearly as patches of darker or lighter shade, depending on the dye used. Some bacteria give rise to distinctive, coloured spots such as the red stains caused by colonies of Bacterium prodigiosum.

Disintegration of casein fibre (Tiolan) following attack by Bacillus mesentericus. Lactophenol cotton blue preparation. × 150. Photo: M. Nopitsch.

Discoloration of fabrics may, however, be due to secondary factors not directly related to the bacterial damage, as for instance in deterioration brought about by perspiration when acids and alkalis are responsible for the colour changes. If extensively damaged articles are exposed to dampness, they develop the putrescent odour associated with sulphurous proteins.

Apart from articles of clothing subject to the action of perspiration, bacterial attack may affect areas of fabric exposed to other bodily excretions. This goes for swim suits, though in this instance bacterial infection of the wool may of course also result from contact with the ground or mud. The actual cause can only be determined by microscopic examination of the damaged parts and by culture tests. Silk rarely shows bacterial deterioration, but casein fibre is highly susceptible and unless treated with a bacteriostatic agent may suffer almost complete disintegration by bacterial proteolytic enzymes.

Aggregations of Bacillus mesentericus on sheep's wool and spun rayon fibres with signs of extensive deterioration. Lactophenol cotton blue preparation. × 150. Photo: M. Nopitsch.



The soil bacteria mentioned so far attack animal fibres exclusively and contribute but slightly to cellulolytic deterioration. One class of bacteria, however, is able, in conjunction with moulds, to destroy even textiles of vegetable origin (cf. page 3593) if these are in a very damp condition and buried in soil or covered with earth and dirt. Mildewing of wool is not destructive to the wool itself as moulds are supported mainly by its non-fibrous components and the wool grease. Considerable damage may, however, be caused by dermatophytic fungi such as Microsporium hypseum and others. Recently attention has been called to Ctenomyces, an ubiquitous member of the Gymnoascaceae family in the subclass of Ascomycetes, which is said to decompose wool completely.

As is well known, the hyphae of hair fungi

Aerobic Soil Bacteria

Name	Gram's stain	Spores
Bacillus mesentericus vulgatus	positive	yes
Bacillus subtilis	positive	yes
Bacillus megatherium	positive	yes
Bacillus mycoides	positive	yes
Bacterium vulgare (Proteus vulgaris)	negative	none
Bacterium prodigiosum (now Serratia marcescens)	negative	none
Bacterium fluorescens liquefaciens (now Pseudomonas fluorescens)	negative	none

penetrate into the hair and disintegrate it from within by the secretion of proteolytic enzymes. This explains why infected areas in the fleece of the living animal soon grow bare, the damaged hairs breaking off and falling out. Such diseases may ruin costly pelts entirely, besides rendering the hairs unsuitable for further processing. *M. Nopitsch*

New! *Fumexol 2*

a highly effective *anti-froth agent*

Sizing: Fumexol 2 ensures a uniform coating of size

Dyeing: Prevents yarn and piece goods from floating on the surface of the liquor

Finishing: Prevents faults caused by the formation of bubbles

Printing: Prevents the frothing of printing pastes
Fumexol 2 has no effect whatever on the shade

Microbial Damage to Vegetable Fibres

Textiles attacked by moulds emit a musty, stale odour, and usually exhibit spore or mould spots of varying size and mostly circular shape. Their colour may be yellow, orange, red to purple, green, brownish olive, or dark brown to almost black. Under the quartz lamp they often appear highly fluorescent.

Whereas individual bacteria are only visible with high powers of the microscope, the conidia, sporangia, and other fruit forms characteristic of the various types of mould may be distinguished with a hand lens. Systematic classification requires the use of a microscope and, possibly, the preparation of cultures.

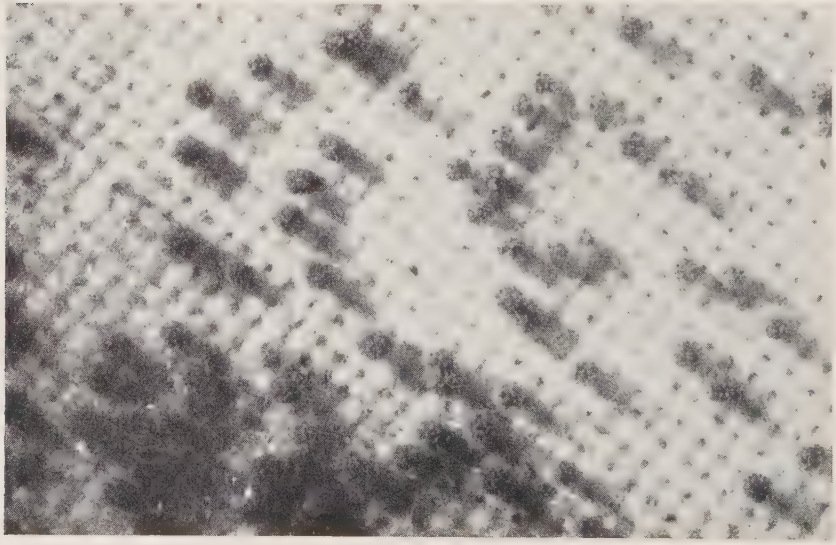
Not all mould fungi are associated with mildew attack on textiles, which is caused only by members of the Phycomycetes and Mycomycetes groups of Eumycetes. The first group includes the class Zygomycetes, one subdivision being the Mucorales, while the Mycomycetes group comprises, among others, the Ascomycetes and Fungi Imperfecti.

The yeasts (Saccharomycetes) and most of the mould fungi known to produce spore spots on textiles, such as the Aspergillaceae and Penicillia, are classed with the Ascomycetes in so far as such moulds do not come within the great group of Fungi Imperfecti, i.e. fungi whose methods of propagation are not completely known yet.

Unlike bacteria, the Eumycetes have a body (thallus) of branched threads (hyphae) which may be either septate (divided by cross-walls) or non-septate. Mould fungi with a non-septate mycelium (network of hyphae) are known as Phycomycetes, those with septate hyphae as Mycomycetes.

The hyphae as a whole form the vegetative part of the plant and grow throughout the substratum, branching freely in all directions. In the cotton fibre, for instance, they are clearly visible inside the lumen after staining. The substratum supplies nutrient substances and in return receives the excretion products of the organism. The mycelium is usually colourless or brownish and by itself does not permit diagnosis of the different species. For this, the asexual and sexual organs of reproduction have to be studied.

In most cases, vegetative or asexual reproduction proceeds by means of special organs. Certain thicker hyphae rise above the substratum and grow characteristic fruiting structures at their tips. Several types are to be distinguished: (1) *sporangia* (sgl. *sporangium*): large, round cell-like receptacles containing small round or oval-shaped spores; (2) *conidia:* certain terminal hyphae of the mycelium, the sterigmata, grow into fruiting bodies. They either are branched or end in a button-like swelling, the conidiophore, at the tip of which special cells (conidia), also more or less rounded, are formed by abscission. These are characteristic in the majority of mould fungi. (3) *oidia:*



Perithecia of Chaetomium globosum on a cotton fabric. Photo: Research Laboratories, Ciba Limited.

without developing fruit bodies some mycelial hyphae break up at the septa into a close series of ovoid cells (oidia).

Sexual reproduction is either by zygospores (e.g. in the Mucorales) or by ascospores forming in tubular spore sacs (asci).

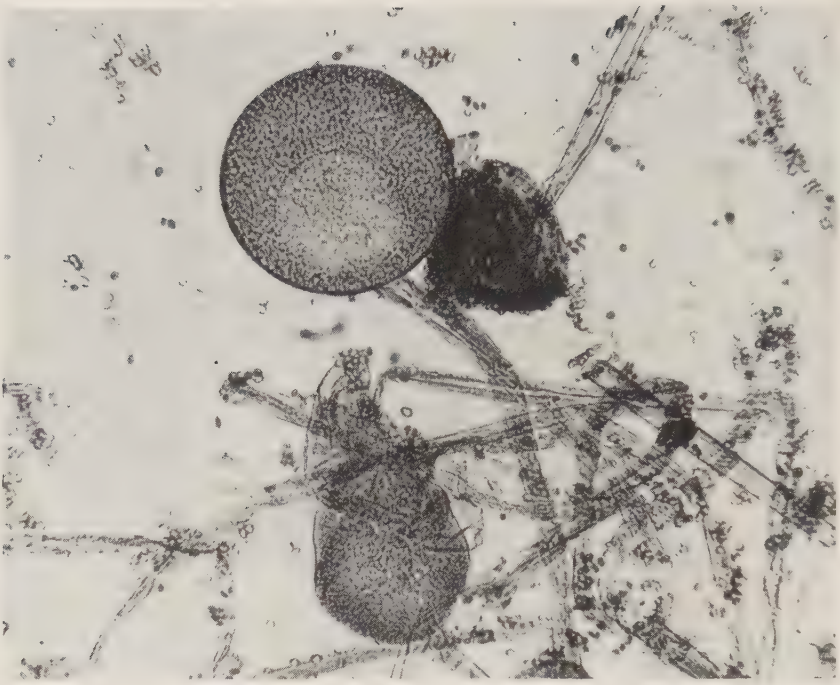
These fruiting structures, whether sexual or asexual, are more or less pigmented and give the mildewed areas their characteristic colouring. Many fungi are also able to dye the substratum on which they grow with colouring matter they synthesize themselves.

The table on page 3595 lists the causes of mould attack on natural cellulose fibres. The occurrence of moulds on textiles and the species and genera demonstrated have been dealt with in numerous publications, notably by American and British authors.

The Phycomycetes (subclass Zygomycetes) are represented by fungi from the order Mucorales, the genera most frequently met with being Mucor Micheli and Rhizopus Ehrenberg. These are ball-headed moulds with tall mycelium, which generally produce black spots on the goods affected. So far about eight species of Mucor and two of Rhizopus have been

Fungi Imperfecti Destructive to Textile Fibres of Vegetable Origin

Name	Family	Sub-family	Form of fruiting bodies	Colour of fruiting bodies
Alternaria Nees	Dematiaceae	Alternarieae	conidia inverted club-shaped, produced in chains	dark-coloured mostly brownish-black
Botrytis cinerea Micheli	Mucedinaceae	Botrytideae	branched conidiophores bearing grape-like clusters of ovate conidia	grey
Chaetomium chartarum	Chaetomiaceae	Spaehrineae	fruiting head borne on mycelium with characteristic tuft of hairs, spores lemon-shaped	brown (now classed with the Ascomycetes)
Cladosporium herbarum	Dematiaceae	Bisporeae	thread-like conidiophores, the ovate spores increasing by budding	yellow to black-green
Dematium	Dematiaceae	Haplographieae	erect, sparsely branched septate conidiophores	brown
Fusarium Link	Tuberculariaceae	Hyalotragmosporeae	usually sickle-shaped conidia with several septa	pink or purple
Macrosporium Fries	Dematiaceae	Macrosporieae	conidia obovate, with three to five transverse and several slanting septa	brown to brownish-black
Monilia Pers.	Mucedinaceae	Oosporeae	conidia at the tips of branched conidiophores, ovate or oblong	light coloured
Stachybotrys Corda	Dematiaceae	Periconieae	conidia borne terminally on thick, longish sterigmata, globose or oval	black
Stemphylium	Dematiaceae	Macrosporieae	septate conidia	mostly black
Verticillium	Mucedinaceae	Verticillieae	erect conidiophores with single conidia borne at the end of branchlets	light coloured



Sporophores (spore-bearing organs) of Mucor mucedo fungus. × 165. Photo: M. Nopitsch.

isolated from textiles. The Mucoraceae mainly attack the auxiliary materials present in fabric, i.e. finishes, sizes, and certain constituents of the lubricants, but not the cellulose. When the finishing agents are used up, or in their absence, the Aspergillaceae make their appearance. It is interesting to note that in culture tests with infected cotton threads placed on malt gelatine the reverse happens: the Aspergillaceae are followed by the vigorously growing Mucorales to the exclusion of all else.

The majority of mould fungi found on textiles belong to the family of the Aspergillaceae (class: Mycomycetes, subclass: Ascomycetes). According to Wegener and Questel, about 26 species of the genus Aspergillus Micheli and 18 of the genus Penicillium Link have been established. In artificial culture their mycelia are low and the conidia of the most varied colours. Green and black, however, are the prevailing colours of the spots caused by these moulds, the commonest species such as Aspergillus glaucus, Aspergillus fumigatus, and Aspergillus versicolor producing olive green to bluish green mycelia, as does Penicillium crustaceum vice Penicillium glaucum. The very common Aspergillus glaucus develops best in moist places on starch and other carbohydrates, while Aspergillus fumigatus is involved in the spontaneous ignition of hay and is pathogenic in birds and other animals, occasionally also in man. Penicillium glaucum is similarly of very wide occurrence and to be seen on many foodstuffs, particularly cereals. Black colonies are formed both by Aspergillus niger, which produces citric acid in fermenting sugar solutions, and by Aspergillus terreus. The conidia of Aspergillus niger are globose, those of Aspergillus terreus cylindrical. Other species of the genus Aspergillus have white (Aspergillus candidus), yellow (Aspergillus flavus), brown (Aspergillus ochraceus), and red (Aspergillus roseus and Aspergillus ruber) conidia and cause spots accordingly.

No less varied in colour are the conidia and colonies of the genus Penicillium, but blue-green to olive and greyish green predominate on the surface of colonies on nutrient agar, while brown, yellow orange, and red colourings are usual on the reverse side. Many species of Penicillium are found on various cheeses, to which they impart their characteristic taste, e.g. Penicillium camemberti in "Camembert" and Penicillium candidum in "Brie". The most common Penicillia on textiles besides Penicillium glaucum are Penicillium chrysogenum, Penicillium citrinum, and Penicillium expansum. The genera Asper-

gillus and Penicillium differ in the form of their conidiophores. In Aspergillus, they terminate in a swelling which may be globose, ovate, or columnar. Radiating from this swelling or vesicle are rod-shaped cells, the sterigmata, containing the conidia which are successively cut off from the elongating tips. In Penicillium the fruiting structure is somewhat more complicated. The conidiophore ends in longish cells or rami which branch verticillately into metulae and again into sterigmata, the latter producing the conidia by abscission.

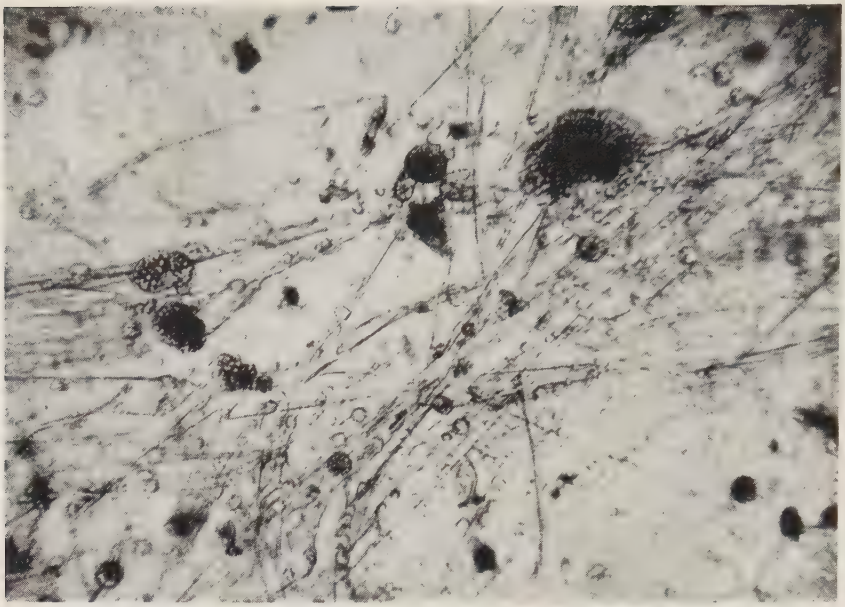
The Fungi Imperfecti also contribute many species destructive to fibres of vegetable origin. Wegener and Questel cite no less than 54. The list on page 3591 has been confined to species mentioned by more than just one or two authors.

In economic importance the cellulosic fibres (cotton, bast, viscose, rayon) rank first among those of vegetable origin used by the textile industries. They are liable to attack not only by moulds, as mentioned, but also by bacteria such as Cellvibrio vulgaris, Cellulomonas biazotea, Corynebacterium sp., Cytophaga rubra, and Sporocytophaga myxococcoides. As a rule, fibres which are in equilibrium with a relative atmospheric moisture content of 100 per cent, are mainly attacked by moulds. If the fibre is over-saturated with moisture, the risk of bacterial infection grows. Galloway and Snow have shown the moisture requirements of fungi to vary with the species. While a relative humidity of over 90 per cent is essential to growth in most species, some—especially among the Aspergillaceae—develop with less. Temperatures of 25–35° C. (77–95° F.) greatly favour the growth of cellulose-destroying organisms. The optimum pH ranges between 7 and 8.5 for bacteria and between 4.5 and 7 for fungi. It is noteworthy that, depending on their origin, cell-free cellulolytic enzyme preparations display their maximum activity at varying pH values. Thus, cellulose decomposition by enzyme preparations from Myrothecium verrucaria mould and Cellulomonas bacteria is quickest at pH values of ± 6 and ± 7.5 respectively.

Mildew formation, in addition to producing spots, may attack the fibre itself. In the latter case, the micro-organisms utilize the cellulose of the fibre as an organic source of carbon. Degradation of the fibre substance ensues, with consequent loss of strength and weight. Such loss is generally made the basis for the quantitative determination of microbial attack.

The fibres are subject to attack both from the lumen and the outside surface. Certain fungi, possibly because they depend on the materials contained in the cells of raw cotton, are apt to attack by way of the lumen, to which they penetrate from the broken ends of the fibre. The corrosive action on cellulose of fungi and bacteria often proceeds according to a fixed pattern which is governed by the fibrillar structure of the fibre. On cotton fibres, for instance, a spiral corrosion pattern may be observed which is produced by the enzyme

Advanced mildew attack on cotton bobbins. Photo: Research Laboratories, Ciba Limited.



Mycelium and conidia of Aspergillus niger, a mould fungus. Magnification 165. Photo: M. Nopitsch.

cellulase penetrating along the spiral microfibrils. It is here that disintegration of the cellulose begins. On viscose, on the other hand, the fungal hyphae often grow along small superficial furrows, parallel to the fibre axis.

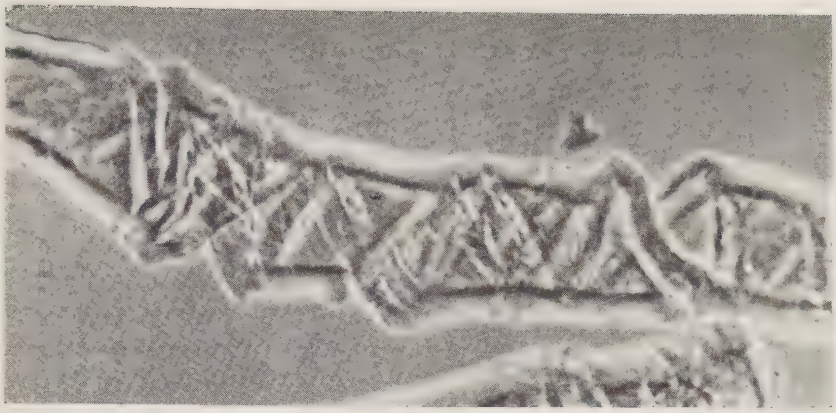
The immunity of cellulose fibres to microbiological attack is in proportion to their freedom from accessory materials and finishing substances. This explains the great resistance of viscose fibres of pure cellulose as compared with untreated cotton. As soon as both types of fibre are soiled, however, or placed on mineral agar and infected with mould fungi, the deterioration of viscose proceeds at a quicker rate than that of cotton.

This fact is explained by differences in the microscopic structure of the fibres, particularly in the degree of crystallinity and orientation of the cellulose, which determine the resistance of the fibres. If there is little crystallinity and orientation, the interior surface of the cell wall is correspondingly larger and thus more exposed to the action of enzymes. Accordingly, resistance to cellulolytic fungi follows a downward curve from ramie, with its high orientation and crystallinity, via raw cotton and mercerized cotton to viscose, which latter possesses large amounts of what may be called amorphous cellulose, and little orientation.

In fibres incrusted with lignin, such as jute, Manila hemp (abaca), or sisal, the submicroscopic lumina of the fibres are more or less filled with lignin, which considerably increases the cellulase resistance of the interior surface of the cellulosic structure. From cotton to hemp, via jute, Manila hemp, and sisal, there is a steady rise in the lignin content of the fibres, and consequently in their resistance to cellulolytic attack. The difference between hemp, which contains practically no lignin, and Manila hemp, which is strongly lignified, is illustrated in the graph on page 3598.

The formation of certain enzymes endows the micro-organisms with their cellulolytic action. According to present knowledge, cellulase is mainly connected with this process, as it breaks down cellulose into cellobiose, which in turn is degraded by cellobiase into glucose. This is the form in which decomposed cellulose becomes digestible by the micro-organism.

If bast fibres are attacked, either the pectins are decomposed, i.e. "dissolved out", in other words, the work of the retting bacteria and moulds is continued; or decomposition of cellulose takes place, as with cotton. The anaerobic bacteria used for controlled retting, e.g. Plectridium pectinovorum, Granulobacter pectinovorum and Granulobacter acrocephalum (tank and pit retting), Bacillus felsineus (sodium carbonate retting), and Bacillus comesii (Rossi retting) absorb pectins only, it is true, but they can have a deteriorating effect if retting lasts too long. In the latter case,



A vegetable fibre degraded by micro-organic attack and swelled with a mixture of caustic soda and carbon disulphide. × 240. Phase contrast photomicrograph by Federal Testing and Research Institute, St. Gall, Switzerland.

pectin B (the cementing substance of the single fibres in the middle lamella) is destroyed in addition to pectin A (which envelops the fibre bundles). Bacillus amylobacter may have a retting effect as well.

The most important pectin-destroying micro-organisms involved in dew retting are Eumycetes such as Rhizopus nigricans, Mucor plumbeus, Mucor hiemalis, Cladosporium herbarum, and Alternaria tenuis. While it may be presumed with some certainty that Rhizopus does not attack cellulose, Cladosporium is also notorious for cellulolytic activity. The danger of causing irreparable damage to the fibre is therefore much greater with Cladosporium. *M. Nopitsch*

Causes of Fungal Deterioration of Native Fibres

(after Wegener and Questel)

Moulds living on textile finishing agents	Destruction of starch and sizes (dyestuffs auxiliaries and finishing agents)	Mucoraceae and certain Fungi Imperfecti, e.g. Verticillium glaucum and Verticillium cinabrum
	Destruction of finishing agents as well as fibre attack through enzyme secretions	Aspergillaceae, Penicillia, Fungi Imperfecti
Moulds continuing the retting process	Digestion of adhering vegetable remains (pectins, lignins) without fibre attack	Certain Mucoraceae, and Alternaria tenuis (of the Fungi Imperfecti group)
	Digestion of adhering vegetable remains with fibre attack through enzymes	Cladosporium herbarum (one of the Fungi Imperfecti)
Moulds breaking down the fibre itself	Secretion of cellulolytic enzymes	Aspergillaceae, Penicillia, Fungi Imperfecti
	Moulds able to deteriorate fibre only after pretreatment in alkaline solutions	
	Moulds which, by their presence, change the pH from acid to alkaline or vice versa, thus preparing a favourable medium for attack by other fungi and bacteria	Certain Aspergillaceae, Penicillia, and Fungi Imperfecti

Coloured woven goods, washing styles, furnishing fabrics, embroidery and knitting yarns

Cibanone Golden Orange 2GT℗ Powder

Original product of Ciba Limited

either as self colour or in combination shades

Dyeing Method CII
can also be applied by Method CIII
for shading purposes

Good light fastness
Fast to kier boiling
Fast to chlorine

Soaping causes practically no change in shade

Decay of Fishing Nets through Microbiological Action

Fishing nets, marine cordage, fishing lines, and other fishing tackle made of fibres (cotton, flax, hemp, sisal, abaca, or coir), if insufficiently treated, may disintegrate with surprising rapidity. Synthetic fibres, on the other hand, such as nylon, Vinyon, Pe-Ce, Perlon, etc., are immune to micro-organisms and therefore increasingly made use of in the fishing industry.

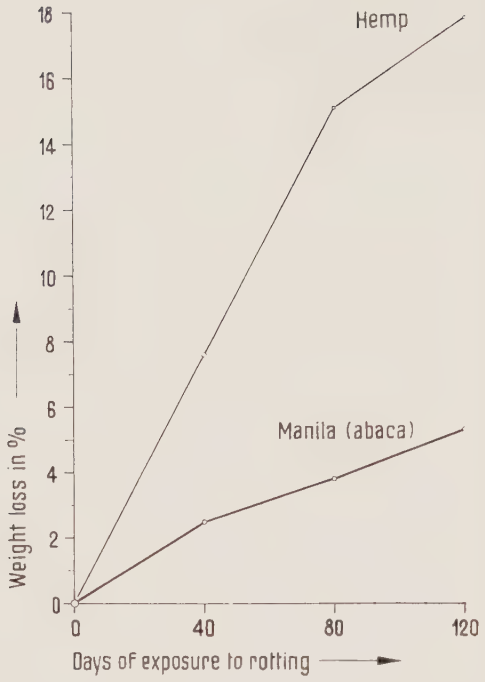
The deterioration of fishing nets and cables from plant fibres is the work of cellulolytic aquatic bacteria inhabiting muddy bottoms (so-called sapropelic organisms) or propelled to the surface by currents. The rotting action of the water therefore is a function of the number of putrefactive bacteria present at the depths reached by the nets, and of the nature and strength of the currents carrying the bacterial layers of water upwards.

Another factor is the oxygen content of the water, as the cellulolytic bacteria concerned are mostly of the denitrifying type, i.e. anaerobic organisms which utilize the cellulose as a source of oxygen. There are also aerobic cellulose-destroying bacteria which decompose plant fibres. In ascending order of resistance to rotting, Brandt ranked fibres as follows: flax, hemp, cotton, Manila hemp, sisal, Pe-Ce fibre, and Perlon. The principal cellulose-degrading bacteria are listed on page 3599.

Deterioration is particularly severe if the cellulolytic and denitrifying actions of different bacteria are combined, as in the case of Bacterium denitrificans (to-day known as Flavobacterium denitrificum), Bacterium punctatum, and others. Microbiological decomposition is often observed to take place more rapidly when several complementary species are involved as opposed to attack by but one micro-organism. In many cases, however, mutually antagonistic forces are also at work.

As with soil bacteria (cf. page 3586), the rotting effect of water and mud bacteria depends on the pH-value of the environment and on the temperature. With rising temperatures, the cellulolytic activity increases until the optimum is reached at about incubator level. In alkaline ponds (pH 8.7 to 8.9) decomposition is particularly vigorous. Bacterial activity decreases with sinking pH and practically ceases in acid media (lakes). If the alkalinity of a fishing water is lowered through accumulation of acid decomposition products, the degradative activity is also reduced.

Two "rotting" bottles for testing the rot resistance of netting yarns. One rotproofed specimen and the usual untreated control sample are suspended in each container. Photo: Hamdorf, Institute of Netting and Materials Research, Hamburg, Germany.



Loss of weight in Manila and hemp fibres due to microbiological decomposition. Chart by Federal Testing and Research Institute (EMPA), St. Gall, Switzerland.

The fact that different waters have different cellulolytic powers explains why the useful life of fishing nets and cordage is not everywhere the same. For testing purposes the material is left untreated. If it does undergo treatment, this should be on the surface only, incomplete, and easily washed off.

It follows that fishing gear has a shorter life in eutrophic lakes, i.e. in water rich in organic substances. Rotting takes place three to four times more rapidly in eutrophic lakes than in mesotrophic, and five to eight times more so than in oligotrophic water.

Quite generally, fishing nets and other tackle are disintegrated less quickly in water than in a muddy bottom. The upper or sapropelic cellulose-destroying layers of the mud are particularly rich in bacteria. The water bacteria which form thread-like or slimy colonies in effluents and the sewage fungi are detrimental to fishing nets not so much on account of their cellulolytic action as by causing the nets to stick together, thus making frequent cleaning necessary.

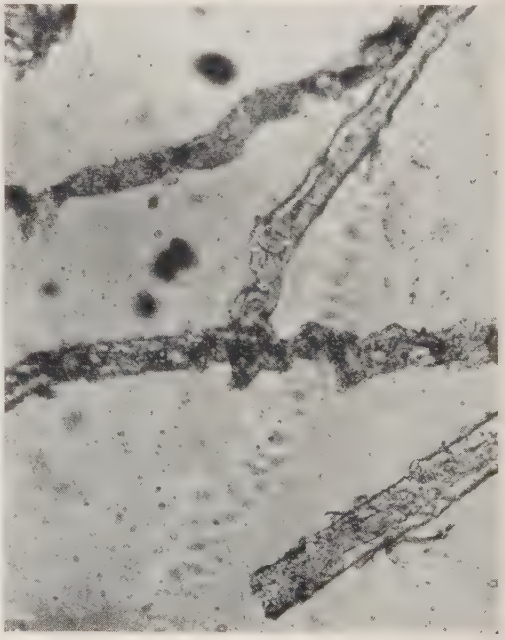
The most common among the water bacteria of wide distribution are Sphaerotilus natans (Chlamydobacteriales) and Leptomitus lacteus (Saprolegniaceae) found in effluents.

Cotton is destroyed by bacteria through local attack only. They secrete an enzyme, cellulase, which transforms cellulose into cellulose dextrins. By means of a second enzyme, cellobiase, these dextrins are further reduced until they are washed away by the surrounding water or digested by the cell body of the organism. This makes clear why the average degree of polymerization of cotton fibres damaged by bacteria does not differ appreciably from that of undamaged cotton—in marked contrast with the action of chemicals.

The deterioration of fishing gear made from flax, hemp, and other bast fibres is initiated by the pectin-degrading retting bacteria (cf. page 3594), which are present in all stagnant waters. They separate the fibre bundles into single fibres, causing a first considerable loss of tensile strength. Then further decomposition of the fibres is effected, as with cotton, by the cellulolytic bacteria present in the water.

M. Nopitsch

Disintegrated cotton fibres from a fishing net. Heavy corrosion has resulted from the bacterial activity. Photomicrograph: Klust, Institute of Netting and Materials Research, Hamburg, Germany.



Cellulolytic Bacteria Destructive to Fishing Tackle from Plant Fibres

	Name	Group	Shape
Aerobic	Cytophaga Winogradsky	Myxobacteriales	enclosed in a gelatinous envelope
	Cytophaga difluens Stanier	do.	do.
	Cellulomonas ferruginea Rullmann	Eubacteriales	spore-bearing, rod-shaped
	Cellvibrio Winogradsky	do.	long, slightly curved rods with polar flagella
	Cellfalcicula Winogradsky	do.	short rods with polar flagella
Anaerobic	Clostridium Omelianski	Eubacteriales (Bacillaceae)	Rods of varying length

A new group of textile auxiliary products

Dicrylan brands

based on acrylic resin

- Dicrylan WG Circular No. 2091 dispersion
- Dicrylan C Circular No. 2088 dispersion
- Dicrylan L Circular No. 2089 solution

According to the brand, the chief fields of application are

permanent handle finishes
coatings
back finishes
pigment binding agents

for raincoat materials
wax cloth
artificial leather
oiled silk
tarpaulins
aluminium bronze coatings

Nearly all types of bacteria and moulds may be found on the hide of the living animal. Dust, dirt, soil, water, fodder, and litter act as continuous sources of infection quite apart from the transmission of micro-organisms by air, insects, or contact with diseased animals. Only a certain number of—mostly pathogenic—bacteria and skin moulds have a damaging effect, e.g. typical pyogenic organisms such as the Streptococci and Staphylococci, and Micrococci, which chiefly affect the glands and destroy the corium by dissolving the collagenous and elastic tissues. In anthrax disease and skin tuberculosis both the epidermis and the corium are involved. Actinomycetes and pathogenic yeasts may also cause injury.

The most serious damage to the hide of the living animal is, however, done by skin moulds or dermatophytes. While fungal diseases of the hide such as trichophytosis, favus, microsporosis, and epidermophytosis tend to affect only the surface, others like kerion go deeper. Some of these fungal disorders of animal hair and hides are transmittable to man, though there are special human forms, too.

In addition to the micro-organisms mentioned, a wide range of other harmful bacteria go into action as soon as the hide is removed from the body and the powers of resistance of the latter are eliminated. In order to avoid gross damage likely to make tanning and dressing of the hide impossible, this must be subjected to preservative treatment without delay. The deterioration of raw hides is almost exclusively the work of bacteria. These are identical with the wool-destroying types referred to on page 3585 *et.seq.*, both wool and skin being proteinaceous materials. The bacilli and bacteria occurring on the skin of the living animal and on fresh and dried raw hides are listed on page 3602.

Globose heads of Aspergillus ustus at different stages of development. The spore heads are buff to olive brown. Photomicrograph: Research Laboratories, Ciba Limited.

Many micro-organisms survive salting, which simply inhibits their growth. Too little salting or gradual adaptation by the spores to the concentration of the salt allows the germs to resume their growth. Besides, repeated reuse of the same curing salt is a frequent source of considerable increase of bacteria. In addition to serious damage to tissue, the cured skin may show orange to reddish brown spots and red to purple discolorations. The spots are due to attack by coloured Micrococci, Sarcinae, Actinomycetes, and rod bacteria, which also destroy the hide substance. Bacteria are also responsible for the discolorations, e.g. Bacterium prodigiosum, Micrococcus roseus, Torula yeasts, and Actinomycetes for red, and Bacterium violaceum for purple shades. In time, the rotting action penetrates deeper; in the course of further processing of the hides and skins, soft, slimy patches appear which are easily pierced, the tissues concerned having become loose and spongy.

Drying the skins as a means of preservation is not practicable in regions with excessive atmospheric moisture. Dried skins should not contain more than 12–15 per cent of water, this being the lower limit for mould growth, whereas bacteria will not develop in less than 30–35 per cent humidity. With many species of bacteria, the drying process merely inhibits further growth, which starts again as soon as the hide or skin is wetted back.

If dried hides or skins are exposed to moisture, the first damage to appear is mildewing, with colonies usually green or black in colour, for instance those of Penicillium commune and Aspergillus niger. When dried stock is "soaked back", all the microbes present multiply once more. There is also the risk of germ-laden soaking liquors—whether previously used or not—acting as fresh sources of in-

Spore spots on the grain side of a calf pelt, caused by bacteria in conjunction with impurities of mineral and organic origin. Photo: Federal Testing and Research Institute (EMPA), St. Gall, Switzerland.

fection. It has proved good practice to use fresh running water of less than 68° F. (20° C.) and to remove dirt, blood, excrements, and easily soluble proteins as quickly as possible. Normal soaking time must not be exceeded and is shorter, the higher the temperature of the water.

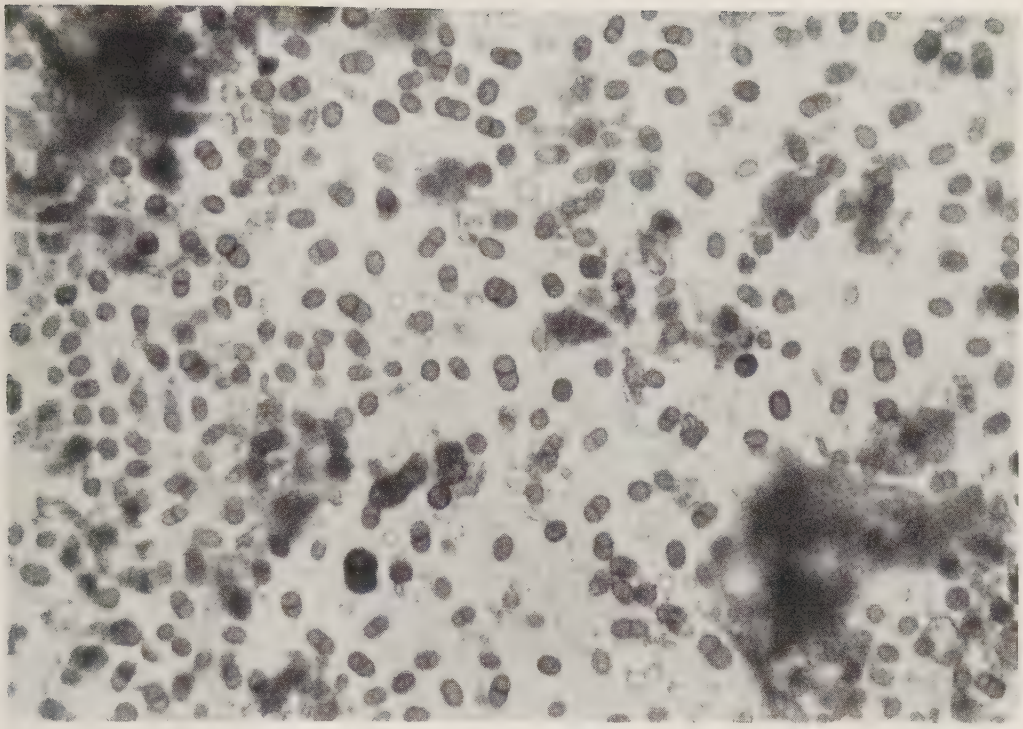
In former times, unhairing was carried out in sweating rooms, but nowadays is usually done in the liming pit. The sweating process is based on bacterial action, or rather on the enzymes formed by the bacteria. It therefore has to be very closely watched if deterioration of the hide substance through bacterial activity is to be avoided. Pure cultures, e.g. of Bacterium fluorescens or Bacillus mesentericus, are sometimes employed for sweating. Immediately following this operation, the hides and skins have to be washed in very cold fresh water so as to flush away the micro-organisms. Liming with quicklime or quicklime and sodium sulphide liquors by no means guarantees efficient sterilization. Liming kills the superficial germs, but not the bacteria in the deeper layers of the hide or skin. The bacteria isolated from these parts are in the main identical with those just mentioned and largely species capable of liquefying gelatine. The older the liming liquor, the more prolific the bacterial growth.

Even if modern enzymatic bates are used there is increased danger of decomposition by microbes, for both pH and bating temperature are highly favourable to the growth of harmful bacteria.

In vegetable tanning liquors there are to be found vast numbers of yeasts and mould fungi as well as Actinomycetes and bacteria, many of which adhere to the tanning agents themselves. Among the yeasts, several species of Saccharomyces have been detected, e.g. Mycoderma and Torula; among moulds, Penicillia, including members of the Cytomyces group, Aspergillaceae, and Mucorales; and among the bacteria, Sarcinae, Micrococci, Bacillaceae, as well as acetic and lactic acid organisms. Moulds and yeasts attack the tanning agents in the first place, thus preventing a

Bacilli and Bacteria Occurring on the Skin of the Living Animal and on Fresh and Dried Raw Stock

Name	Microscopic appearance	Oxygen requirement	Gelatine liquefied	Colour produced	Notes
Bacillus phlegmonis emphysematosae (Clostridium perfringens)	short rods, oval spores	anaerobic	yes	greenish brown	pathogenic
Bacillus putrificus (Clostridium lento-putrescens)	slender straight rods, oval spores	anaerobic	yes	none	apathogenic, putrefactive
Bacillus anthracis (anthrax bacillus)	large rods, partly in chains, threads; ovoid spores	aerobic	yes	none	pathogenic
Bacillus mycoides	oval spores	aerobic	yes	none	generally apathogenic
Bacillus mesentericus vulgatus	slender rods, oval spores	aerobic	yes	none	non-pathogenic
Bacillus megatherium	very large, uncommonly broad cells with one large spore each	aerobic	yes	none	non-pathogenic
Bacillus subtilis	short rods, oval spores	aerobic	yes	none	usually non-pathogenic
Bacterium vulgare (Proteus vulgaris)	slender rods, no spores	aerobic and anaerobic	yes	none	poisonous products of metabolism
Bacterium fluorescens liquefaciens (Flügge)	thick and slender rods, no spores	aerobic	yes	yellowish green, fluorescent	pathogenic (pus)
Bacterium coli (Escherichia coli)	short oval rods, no spores	aerobic	no	none	occasionally pathogenic
Bacterium prodigiosum Ehrenberg (Serratia marcescens)	short rods like cocci no spores	aerobic	yes	bright red	non-pathogenic
Bacterium pyocyaneum (Pseudomonas aeruginosa)	thick and slender rods, no spores	aerobic	yes	bluish green	pathogenic, pus producing
Bacterium violaceum	thin short rods	aerobic	yes	purple	apathogenic



Spores of Dematium pullulans. Photomicrograph: Research Laboratories, Ciba Limited.

thorough tanning action. Chrome tanning liquors normally lack the essentials favouring bacterial growth.

Finished leather is mainly susceptible to attack by yeast-like and common moulds which degrade the oils in leather and, when these are consumed, can be destructive to the leather itself. The grain of processed leather may, for instance, show flaws due to the action of dermatophytic moulds in the living animal; these blemishes form smooth superficial patches with loss of grain. Even the underlying tissue may be seriously impaired and flaccid. Deep-seated mycoses result in cavities, often perforating the skin, while dermatophytes produce pin-head sized crater-like erosions and pitted surfaces.

The bacterial stains originating in raw stock and at one time erroneously termed "salt stains" show up as yellow, orange, and rusty-brown spotty depositions on the flesh side, taking on a brownish to black-green colour in chrome tanned leathers. In the grain, these spots occasionally also spread out as patches. As mentioned earlier, they are due to bacteria, like the discolorations (cf. table on page 3602).

The pickled pelts are specially liable to mildew attack. In leather, mould formation is noticeable by its characteristic stains and odour. Milky white or cream-coloured mucous spots appearing on the grain are caused by faulty fermentation, the affected areas failing to absorb the tanning agent. In the drying process they turn black.

Distortion of the grain layer is traceable to excessive swelling of the pelt with acids, which may result in hydrolysis of the interior portions of the hide. On vegetable-tanned leather undergoing drying, sharply outlined circular spots of varying colour are produced by moulds. Dematium species, for instance, give deep bluish purple spots, and Penicillia and Aspergillaceae are responsible for various other shades.

Owing to the rapid advances in the field of preservation and disinfection methods, the above-mentioned forms of leather damage can now be largely avoided. A great many substances are available to-day for safe use in the preservative treatment of raw hides and skins without risk of impairing their tanning properties.

M. Nopitsch

The first step in testing for micro-organic attack is to prepare suitable samples from the suspected materials for examination under the microscope at magnifications of 250 to 400 diameters. Staining with appropriate dyes may facilitate identification of the micro-organisms responsible for the damage. Thus, lactophenol cotton blue shows up the hyphae and fruiting bodies of moulds, while most bacteria have sufficient affinity for carbol-fuchsin (see table below) to reveal their presence and even their shape. Comparatively low powers are adequate for examining moulds under the microscope; bacteria, however, often require magnifications of 400 to 600 diameters.

Identification of fungi proceeds from the shape of their fruiting structures, since classification of moulds is only possible on the basis of their vegetative and sexual reproductive organs. With bacteria, slight dyeing of the preparations with carbol-fuchsin suffices to distinguish between Micrococci, Streptococci, Sarcinae, the various types of rod organism, Spirilla, Myxobacteria, etc. A very important staining method for the differential diagnosis of bacteria is that by Gram's stain, which divides them into gram-positive and gram-negative species (see table below).

In the majority of cases, examination under the microscope is followed up with a number of culture tests. Sample particles from the infected textile or leather goods are placed on sterile nutrient media and incubated at the temperature most favourable to the development of the bacteria or moulds to be studied. Tests on culture media supply information on the nature and degree of infection in the test material as well as on the appearance, colour, and texture of the colonies formed. In bacterial deterioration, more especially, the microbio-

Reagents for Bacterial Staining

Name	Composition	Use
Carbol-fuchsin	100 cc. distilled water 5 cc. carbolic acid 10 cc. saturated alcohol-fuchsin solution	concentrated, for direct staining; 1 : 4 solution for after-treatment
Carbol-gentian violet	100 cc. distilled water 1 cc. carbolic acid (phenol) 10 cc. saturated alcohol gentian violet solution	for direct staining, concentrated
Lugol's solution	300 cc. distilled water 2 g. potassium iodide 1 g. iodine	for decolorizing
Methylene blue (after Löffler)	100 cc. distilled water 1 cc. 1% solution of caustic potash 30 cc. saturated alcohol methylene blue solution	for direct staining, concentrated
Gram's stain	1. Fix preparation in the flame 2. Stain for two minutes in freshly filtered carbol-gentian solution 3. Treat, without rinsing, for two minutes in Lugol's solution 4. Decolorize in a 96% solution of alcohol until no more stain leaves the preparation, usually for one minute 5. Rinse thoroughly in water 6. Aftertreat with dilute carbol fuchsin 7. Rinse and dry	for differentiation between gram-positive and gram-negative bacteria

logist often has to resort to special staining methods, inoculation of nutrient media and solutions, and study of physiological behaviour, if he wishes to obtain clean-cut results. The most important culture media for growing micro-organisms are listed on page 3607.

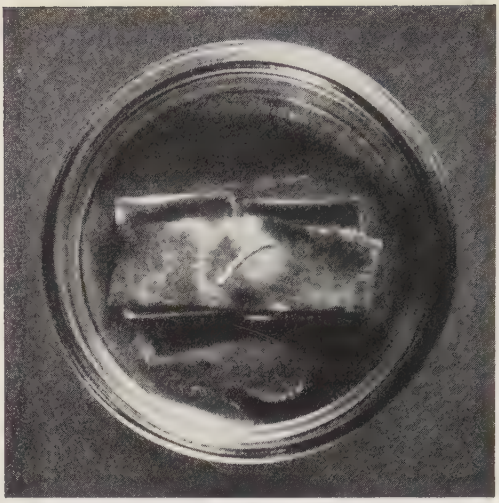
It is advisable to sterilize the nutrient broths and media by steaming for half an hour on each of three consecutive days. All tools, utensils, and glassware must likewise be carefully sterilized or maintained sterile. The nutrient broth (cf. table on page 3607) is also variously mixed with—apart from lactose and glucose—serum, ascites fluid (from the peritoneal cavity), litmus solution, and china blue solution. The special media in use are very numerous and widely employed in the identification of bacteria. They facilitate the classification on physiological characters (e.g. ability to produce acids, morphology of the colonies, and rate of growth, ability to cause fermentation, etc.).

Nutrient or broth gelatines (cf. table on page 3607) serve to determine if a gelatine-liquefying microbe is under examination. To this end, a stab-culture is prepared in a test tube with the aid of a platinum needle, this making it easier to observe liquefaction than with normal streak culture in which a platinum-wire loop is drawn across the surface of the medium.

By repeated reinoculation of cultures the microbiologist finally obtains pure cultures, i.e. such as contain only one species of organism. During the whole operation he must of course guard against introducing any new germs and work with every sterile precaution. The inoculating needle is regularly heated until red hot, both before and after use, the rims of glassware and cotton wool plugs are "flamed", and the hands disinfected at frequent intervals. Intrusion of other germs when carrying out inoculation may be avoided if the Petri dish is held upside down while sowing the culture. Pure cultures make it possible to study the macroscopic appearance of the colony, the microscopic shape of the bacteria, and their physiological and chemical properties. Continued purity of the culture must be verified by frequent checking of the microscopic preparations with powers of 600 to 1000 diameters (oil immersion). The preparations are made either by pressing a sterile cover-glass under sterile conditions on the colony, or by means of smears with the inoculating needle or wire loop.

Three stages in the preparation of a pure culture. Top, heat sterilization of platinum-wire loop prior to transferring bacteria from a culture tube; centre, inoculating the culture medium with criss-cross strokes of the wire loop; bottom, pouring a tube of nutrient into a Petri dish afterwards to be sterilized in the steamer (to the right). Photos: Hessland.

Identification of damage in cellulosic textiles involves dyeing with congo red, or swelling reaction tests in 10–15 per cent caustic soda or a mixture of even parts of 15 per cent caustic soda and carbon disulphide. The swelling reactions in particular are a sure means of distinguishing between the undamaged fibres —which show globular swelling—and microbiologically or chemically deteriorated fibres. All tests for determining the presence of micro-organic attack are based on the change in reaction shown by the outermost zone of



Moist chamber for testing the susceptibility of textile fibres to mildew attack. Photo: Hessland.

fibres (cuticula and primary wall) when it is damaged.

In the tropics, the effectiveness of protective treatments can be assessed immediately in field tests. A substitute for these is offered in the tropical chamber test, in which the temperature and moisture content of the air are subjected to periodical changes in order to reproduce the conditions of field tests as closely as possible, for instance in the Cooke and Vicklund test. Other, additional methods are the soil-burial and the soil-suspension test. In the latter case, a strip of fabric is steeped in a soil suspension and then placed on a mineral nutrient agar without organic carbon source and incubated. The sandbag method according to Dean, Strickland, and Berard is based on the same principle.

For routine comparison tests of fungicidal substances the pure culture methods with strains of Myrothecium verrucaria, Chaetomium globosum, Aspergillus niger, and other moulds have special usefulness. A mineral culture medium containing no organic carbon is used for cellulolytic fungi so that the organism has to rely on the cellulosic fabric for any carbon it may require. Attack of the fibre is evidenced as a determinable loss of strength. Pure culture tests carried out under appropriate conditions give reproduceable results within a fortnight, though these should be interpreted with reserve.

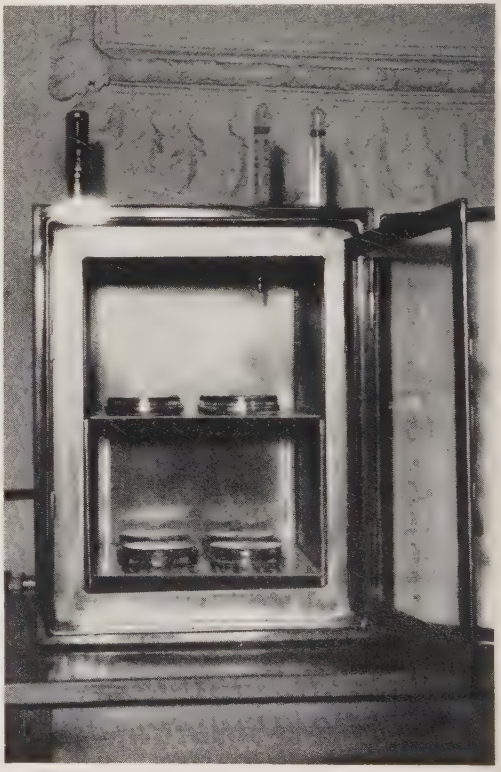
In the study of fungicidal efficiency of textile finishes or leather preservatives the author has employed the following laboratory method: —

A series of Petri dishes is transformed into moist chambers by placing in them glass cubes of a size leaving enough room for adding about 5–10 cc. of sterile water. The test material (thread or fabric) is placed on the blocks and must on no account come into direct contact with the water. The spores from one of the moulds mentioned are inoculated on to the middle of the samples and their development registered by direct observation, photography, and breaking tests. In order to make the conditions of test still more stringent, two further samples of fabric may be subjected to flushing in running water and to a surface abrasion test respectively.

The manometric method developed by Siu and Mandels is based on the oxygen consumption of the test fungus whose growth is more or less rapid. Reproduceable results are obtained in under a week.

In order to test the effectiveness of a bactericidal (germ-killing) or bacteriostatic

Incubator with Petri dishes containing cultures. Bacteriological laboratory of the Clothing Physiological Research Institute at Schloss Hohenstein, Germany. Photo: Hessland.



Culture Media for Propagation of Microbes

Designation	Composition	Use	pH
Nutrient agar	1000 cc. meat broth 10 g. peptone 3 g. common salt 2 g. sodium phosphate 20–30 g. agar-agar	Bacteria	7.4
Lactose or glucose bouillon	same as above, plus 1–2% lactose or glucose	Bacteria	7.4
Bouillon gelatine	100–180 g. gelatine 5 g. meat extract 10 g. peptone 5 g. common salt	Bacteria, for demonstration of proteolytic enzymes	7.4
Malt gelatine	30 g. malt extract 150 g. sheet gelatine dissolved in 820 cc. water	Moulds	6.0
Sopp's medium	Meat-peptone nutrient solution containing: 3% glycerin 3% cane sugar 10% gelatine or 2% agar-agar	Moulds	6.0
Czapek's medium	in 100 cc. water: 0.3 % sodium nitrate 0.1 % potassium phosphate, K_2HPO_4 0.05 % magnesium sulphate, $MgSO_4 . 7H_2O$ 0.05 % potassium chloride 0.001% ferrous sulphate, $FeSO_4 . 7H_2O$ 3 % cane sugar 1.5 % agar	Moulds	6.0
Maltose or glucose peptone agar	in 1 l. of water: 20 g. agar-agar 40 g. maltose or glucose 10 g. peptone	Dermatophytes	

(growth-inhibiting) finish, the author uses the following method: —

10 cc. of sterile tap water or physiological saline or sterile nutrient solution is filled into a test-tube. Two loopfuls of the pure culture bacteria are introduced into this solution, with the usual precautions, and placed in the incubator. After about 24 hours, a loop of yarn or a small section of the sample fabric weighing about 1 gm. is placed in the solution, and the test-tube returned to the incubator after again sealing it with the sterile cotton-wool plug. Bacterial activity is studied by taking out test specimens at regular intervals, mounting them in lactophenol cotton blue, or, in the case of wool, in Herzog's methylene blue or indigo-carmine solution, Pauly's diazo reagent, or some other reagent, and examining them under the microscope.

Damaged parts are stained blue by the first three reagents and reddish brown by the last. As bacterial deterioration progresses, the wool hair is split up into its spindle cells, the proteolytic enzymes of the bacteria attacking chiefly the amorphous keratin or cementing intercellular substance whereas the crystalline alpha keratin of the scale cells and the gamma keratin of the spindle cells are insoluble.

The test is designed to determine the extent to which bacterial attack has modified the treated wool as compared with two specimens of untreated wool adjusted to a pH of 7.0 and 8.5 respectively and as compared with its initial condition. The control fabric should be completely decomposed by the time exposure to attack ceases. The longer the original (undamaged) condition of the untreated sample is preserved and the greater its residual strength, the higher the efficiency of the bactericidal or bacteriostatic treatment. The method is somewhat slow, since—depending on the virulence of the particular bacteria under study—extension of the tests over one or even two months may be required. Other investigators proceed differently, viz. by spraying the test samples with a bacterial suspension and placing in a moist chamber. Sterile water is poured on to the floor of the chamber so as to keep the moisture content of its atmosphere at a constant level. As with the method of procedure first described, the moist chamber is maintained at blood temperature, i.e. 98.6° F. (37° C.). Tests on organisms destructive to leather are carried out along the same lines as for microbes invading textiles.

The deterioration of textile fibres of vegetable origin caused by cellulose-destroying aquatic bacteria (in fishing nets, etc.) is tested under the microscope. Both the state of preservation of the textiles and the identity of the bacteria involved are investigated. According to Klust, caustic soda of 19° Bé. (about 31° Tw.) has proved useful in testing the effect of cellulolytic bacteria. The corrosion due to the action of bacterial enzymes shows in the fissured appearance of the fibres.

Cellulose decomposition in water, the degree of which depends both on the "rotting power" of the body of water in question and on the resistance to rotting of the nettings, may be determined by means of the physical activity test according to Meseck (1929) and von Brandt. It consists in tensile strength tests of the wet yarn and is expressed as percentages of strength of tested yarn in terms of the untreated newly manufactured yarn.

Incubator for tube culture tests in the bacteriological laboratory of the Clothing Physiological Research Institute at Schloss Hohenstein, Germany. Photo: Hessland.

These tests may be made at varying depths of water. The rotting resistance of a yarn is measured by submerging it in a lake, either untreated or after treatment with a specific preservative, and determining the time required for 80 per cent rotting of the yarn. For the sake of simplicity, the degree of preservation is expressed in "rotting values", which correspond to the rotting power of the water over the period elapsing until the yarn under test is destroyed. The higher the value, the more effective the rotproofing and the longer the life of the fishing nets or marine cordage in question.

Testing for rotting resistance in the laboratory is feasible with flasks containing sapropelic material from water bottoms, and maintained at an incubator temperatur of 98.6° F.; this shortens the testing time considerably. Strength is tested in the same way on hanks of yarn by the physical activity test.

M. Nopitsch

NEW

Fast to light, level, neutral grey shades

on loöse wool, slubbing, yarn, and piece goods with

Chrome Fast Grey FBL

Circular No. 697

Chrome Fast Grey FBL is readily soluble, stable to lime,

and can be readily and evenly chromed

Reserves effect threads of cotton and viscose rayon

Chrome Fast Grey FBL is also suitable for printing on *wool*, *silk*, and *slubbing*

Animal fibres require no special treatment with antiseptics to protect them against attack by saprophytic *bacteria*. Easily the best method of increasing the resistance of wool to saprophytic and gelatine-liquefying bacteria has proved to be the use of chrome, as the formation of a wool chromium complex blocks the protein-degrading enzymes. However, care must be taken, when chroming, not to damage the wool fibre. The bacteriostatic effect depends on the amount of chromium taken up by the fibre; nevertheless, the difference in bacterial resistance between unchromed and weakly chromed wool is greater than that between weakly and heavily chromed wool. A wool hair whose histological structure is unimpaired by environmental factors or processing possesses greater resistance than a fibre modified, however slightly, by chemical or mechanical action. The state of the epithelial scales of the hair is of decisive importance in this respect.

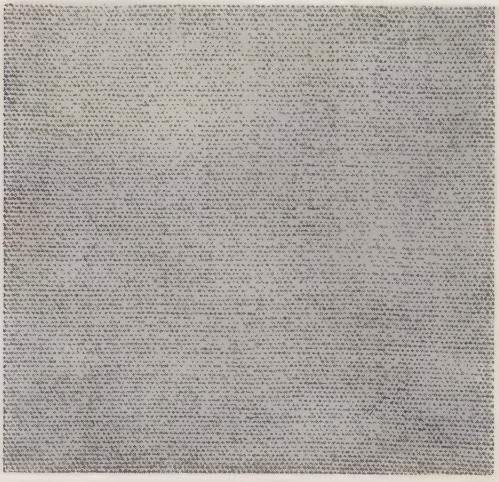
Besides chroming, moth-proofing processes also provide good protection against saprophytic and gelatine-liquefying bacteria. It goes without saying that treatment with antiseptics (salicylic acid, cresol, chlorocresol, tri- and pentachlorophenol, chloroxylenol, etc.) offers more or less permanent protection due in part to true bactericidal action. Tannins and inorganic disinfectants such as copper salts and mercury salts, whether combined with antiseptics or not, have a similar effect. Washing, however, is likely to remove them to some extent, while chromed wool retains its resistance in laundering, unless it has suffered some other damage.

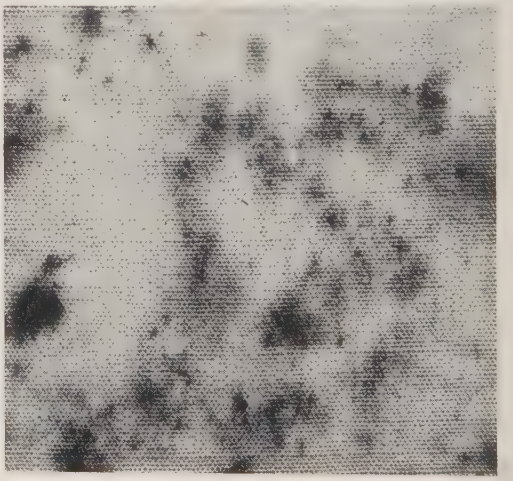
Another protective measure against bacterial attack on wool consists in adjusting it to a low pH. At optimum pH, that is between pH 7.0 and pH 8.5, bacterial activity is greatest, temperature being an additional factor. If, however, the pH of the wool is lowered to less than 4.5 and if bacterial attack occurs in a liquid medium adjusted to the same pH, even wool that is otherwise unprotected may be preserved intact for a fairly long period, under experimental conditions. In practice, the effect is hardly a lasting one since, as soon as the pH shifts towards the critical region of neutral or slightly alkaline reactions because of outside influences or bacterial excretions, the degradative action of the bacterial enzymes sets in.

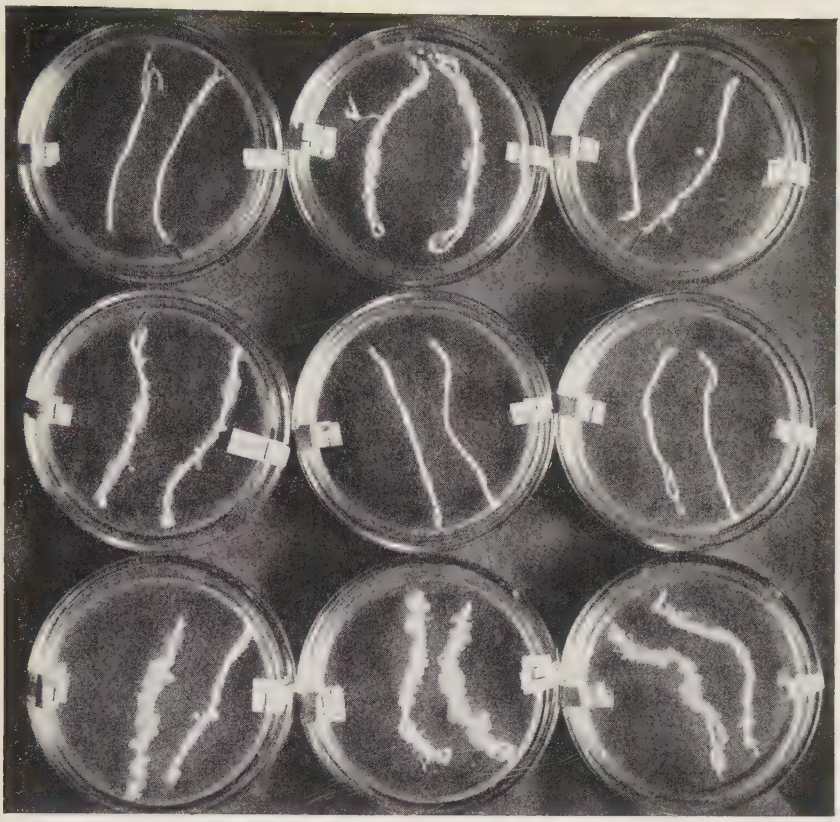
Restoration of wool damaged by bacteria is impossible, only the progress of bacterial decay can be halted by immediate treatment in acid baths and by chroming. Disintegration, however, and patchy colour of the affected areas have to be accepted.

Mildew proofing of wool is not very different from that of *vegetable fibres*. As mentioned earlier, to grow at all, moulds at first require the accessory materials present on wool, such as wool fat, lubricants, soap residues, and other

Fabric samples tested, under identical conditions, by the test chamber method. The mildewproofed fabric (left) is completely free from attack, while the control shows numerous brightly coloured mould colonies. Photo: Hessland.





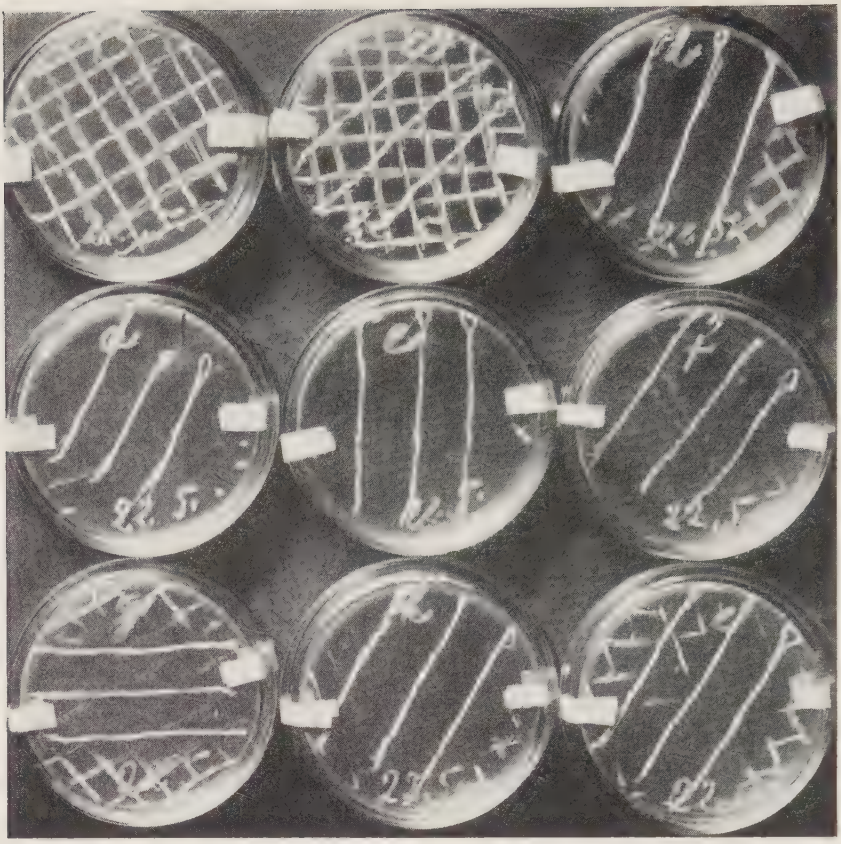


Testing a bactericidal antiseptic by placing treated, but unsterilized, strands of fibre on nutrient agar. This method serves to detect the growth of air-borne organisms. Bactericidal efficiency is found to be greatest where no, or very few, bacterial colonies develop. Tests carried out by the author. Photo: Hessland.

finishing agents. Normally, the fibre itself is not damaged unless bacterial activity has already broken down the protein into simpler amino acids. An exception are certain dermatophytes of the skin and hair which require no such preparation of their food supply. Where attack has not reached this stage yet, wool is treated like the vegetable fibres. Care must be taken to avoid mould development on oils, sizes, and other finishing agents, which are particularly liable to it in summer if left standing for some time. Mildewing of sizes, oils, and finishing agents containing hydrocarbons, natural fats, proteins, and hygroscopic substances may easily be prevented by adding antiseptics such as chlorocresols, chloroxylenols, tri- and pentachlorophenols, anilides of salicylic acid, and a great many other such products.

Reasonably clean vegetable fibres that have been freed from their natural as well as adventitious impurities are, generally speaking, little susceptible to mildew and bacterial attack. The cellulolytic bacteria responsible for the rotting of fishing gear form an exception (cf. page 3599).

Once sizes, lubricants, and finishing agents have been applied to the fibres and the worn garments impregnated with dirt and bodily secretions, very rapid and heavy mildewing develops on textiles of vegetable origin if the atmosphere is sufficiently damp and warm. For this reason, tenting, canvas tilts, firehoses, and other equipment in frequent contact with the ground or with mud and exposed to all weathers, in other words, items readily infected with spores require a fungicidal dressing. The zinc, copper, and mercuric salts of organic acids, and phenols have been specially recommended for the purpose. The author has demonstrated their efficiency in combination with the corresponding salts of chlorophenols and their homologues as well as of bivalent and polyvalent phenols. Anilides of aromatic acids have also proved their worth. To these may be added the sodium salts of chlorocresols, chloroxylenols, tri- und pentachlorophenols, phenylphenols, and the free alcohols, usually made water-soluble with emulsifying agents. The copper salts of cellulose glycollic acid are thought to be specially



Testing for bactericidal efficiency by placing the textile fibres on nutrient agar to which a loopful of a bacterial culture has shortly before been applied under sterile conditions. The fainter the latticed lines of bacterial growth near the fibres, the more efficient the bactericidal finish. Tests carried out by the author. Photo: Hessland.

effective, but quaternary ammonium bases and similar compounds are also serviceable under certain conditions. The free aromatic combinations of the compounds mentioned often have a more drastic effect on mildew than the salts, but are either relatively volatile or apt to be leached out during wet processing and soaping. This drawback may be overcome if the aromatic substances which have the antiseptic effect are deposited in and on the fibre as salts of heavy metals. Not all the highly effective metal compounds are suitable, as the deep shades produced by some of them bar them from use with textiles that are to remain undyed or to receive a special shade.

With cellulosic materials, a method of prevention other than by killing the micro-organisms with toxic substances consists in modifying the cellulose chemically in such a way as to eliminate enzymatic action on the cellulose molecule from the outset. Acetyl cellulose as present in acetate rayon is an instance of such a mould-resistant cellulose derivative. The acetyl residue may also be replaced by other groups (e.g. the ethyl residue).

In view of the fact that fibres containing lignin are more resistant to microbiological deterioration than are those of pure cellulose (cf. page 3594), it has become the practice to fill up the submicroscopic lumina of the cellulose fibres with mould and bacteria resistant substances. These form a barrier between the cellulose and the enzyme cytase, which is thus prevented from breaking down the former. Impregnation with synthetic resins has proved particularly effective. Preventive treatments of this type are waterproof and afford good permanent protection.

The substances generally used for proofing *fishing tackle* made of vegetable fibres are tanning extracts from catechu, mangrove bark, quebracho, and local tannins together with alumina compounds and copper salts, also tar products (creosote). In order to increase effectiveness, a special tanning with bichromate is sometimes added to the other treatments. By such combined methods, mildew resistance may be made to last from five to twenty times longer. The three-bath process with tanning agents followed by special tanning with po-

tassium dichromate and subsequent treatment with cresosote is considered particularly suitable, as it confers a very long life on the nets and other fishing tackle even in water of great rotting power.

In the *tanning and dressing of leather*, preservative and disinfectant treatments are heavily relied on for the control of bacterial and mildew attack. Common salt is the chief preservative for raw skins; it must be pure and notably free from calcium and magnesium salts. Well-granulated rock salt is best suited. Salt should never be used twice as it then contains from 500 to 5000 times as many bacteria as fresh material. If soda is added, the appearance of spore spots may be prevented, though not the red and purplish blue discolorations due to bacteria which show optimum growth in the alkaline region. A further improvement is obtained by adding naphthalene to the soda salt, but the use of acids and acid salts is not to be recommended. Zinc oxide is the only inorganic salt suitable in combination with rock salt.

As constituents of various commercial products chlorophenols and cresols do not always yield satisfactory results because of the tanning action of the free phenols; compounds with sodium silicofluoride or β-naphthol are more reliable. Even better results have been claimed for compounds of chlorophenols combined with alkylated naphthalene-sulphonic acids.

In the soaking process, the same disinfectants are added to the soaking liquor which have proved their worth in the textile industry, viz. phenols, chlorophenols, cresols, naphthols, mercuric compounds, etc. The germicidal property of lime and the sulphides being negligible, the pelts must be subjected to special preservative treatment. Its most important phase is "pickling", that is a treatment with common salt and acids, e.g. a one per cent solution of sulphuric acid. Such solutions inhibit the growth of bacteria owing to their acidity, but fail to prevent the development of moulds which, on the contrary, thrive in acid media. Therefore, simultaneous use of specifically fungicidal agents, notably chlorophenols, is strongly indicated.

With vegetable tanning liquors the same compounds in somewhat higher concentrations are used to inhibit mucous fermentation. In order to prevent mildew attack on dressed leather, chlorophenols, chloronitrophenols, chlorocresols and chloroxylenols, phenyl mercury compounds, and similar salts are employed. *M. Nopitsch*

New! *Fast Leather Black CL* Circular No. 710

Yields bloomy black shades of very good fastness to light and good all-round fastness on leathers of all types

Fast Leather Black CL is readily soluble, stable to hard water, possesses high tinctorial power and does not bronze in high concentrations

Fast Leather Black CL is also used as a saddening component for blue and brown dyeings, and as a dyestuff for black pigment finishes

Bibliography

Microbiology, General

Annual Review of Microbiology. London.

Carter, C. F. Microbiology and Pathology. 5th edition. London, 1953.

Rippel-Baldes, August. Grundriß der Mikrobiologie. 2nd ed. Berlin, 1952.

Rokitzka, Anastasia. Allgemeine Mikrobiologie. Munich, 1950.

Microbiological Method

Cowdray, E. V. Laboratory technique in Biology and Medicine. 3rd. ed. London, 1953.

Kahlfeld, Franz. Nährboden-Technik. Leipzig, 1942.

Strassburger, Eduard and *Koernicke, Max.* Das kleine botanische Praktikum für Anfänger. 12th ed. Jena, 1950.

Bacteriology

Breed, Robert S. Bergey's Manual of Determinative Bacteriology. Baltimore, 1948.

Lieske, Rudolf. Kurzes Lehrbuch der allgemeinen Bakterienkunde. 2nd ed. Berlin, 1926.

Lehmann, Karl Bernhard and *Neumann, Rudolf Otto.* Bakteriologie, insbesondere bakteriologische Diagnostik. Vol. I: Atlas. Munich, 1926; vol. II: Allgemeine und spezielle Bakteriologie. Munich, 1927.

Mycology

Galloway, L. D. and *Burgess, R.* Applied Mycology and Bacteriology. 3rd ed. London, 1950.

Lindau, Gustav. Kryptogamenflora für Anfänger. Vol. II, Pt. 1: Die mikroskopischen Pilze. Berlin, 1922.

Niethammer, Anneliese. Technische Mykologie. Stuttgart, 1947.

Smith, G. An Introduction to Industrial Mycology. London, 1946.

Thom, Ch. and *Raper, K. B.* Manual of the Aspergilli. Baltimore, 1945.

Various Authors. Symposium in Mildew Resistance. American Society for Testing Materials, 1943.

Textile Industry

Abrams, Edward. Microbiological Deterioration of Organic Materials. Nat. Bur. of Standards Misc. Publ. 188, U.S. Dep. of Commerce. Washington, 1948.

Dépierre, Joseph. Traité élémentaire des apprêts des tissus de coton, blancs, teints et imprimés. Paris, 1887. (Die Appretur der Baumwollgewebe. Vienna, 1906.)

Georgiewics, Georg. Lehrbuch der chemischen Technologie der Gespinstfasern. Leipzig and Vienna, 1924.

Glafey, H., Krüger, D., and *Ulrich, G.* Technologie der Wolle. Berlin, 1938.

Herzog, Alois and *Koch, Paul August.* Fehler in Textilien. Heidelberg, 1938.

Matthew, J. M. and *Mauersperger, Herbert R.* Textile Fibres, their Physical, Microscopical and Chemical Properties. 5th ed. New York and London, 1947.

Nopitsch, Moritz. Textile Untersuchungen. Stuttgart, 1951.

Siu, Ralph G. H. Microbial Decomposition of Cellulose. New York, 1951.

Thaysen, A. G. and *Bunker, H. J.* The Microbiology of Cellulose, Hemicelluloses, Pectin and Gums. London, 1927.

Leather Industry

Handbuch der Gerbereichemie und Lederfabrikation, edited by *Bergmann, Max.* Vienna, 1931–44.

Hausam, Willi. Die Bakteriologie in der Lederindustrie. Stuttgart, 1946.

Stather, Fritz. Haut- und Lederfehler. Vienna, 1934.

Stiasny, Edmund. Gerbereichemie (Chromgerbung). Dresden and Leipzig, 1931.

Wilson, J. A. Modern Practice in Leather Manufacture. New York, 1941.

Fishing Industry

Brandt, Andres von. Netzkonservierung und Netzpflege. Hamburg, 1948.

Brandt, Andres von. Arbeitsmethoden der Netzforschung. Stuttgart, 1947.

Best fastness to wet treatments by developing

Coprantine Dyes with *Coprantex B*

Original product of Ciba Limited

Applied on the winch, jig, or mangle

Can be applied in anti-creasing or anti-shrinking baths, in which application it gives particularly good fastness to washing

Cibalan Dyes

- *Excellent fastness to light, washing, and milling*

- *Short dyeing time makes for increased production*

In machine dyeing, the process can be further shortened by entering the goods at 185–195° F. (85–90° C.).

The following brands are specially suitable:—

Cibalan Yellow GRL, 2BRL
Cibalan Orange RL
Cibalan Scarlet GL
Cibalan Red 2GL
Cibalan Brown BL, 2GL, TL
Cibalan Bordeaux RL
Cibalan Violet RL
Cibalan Grey BL

- *Good exhaustion of the dye-bath ensures accuracy in working*

- *Preserve quality of the fibre—increase spinning yield*

Chlorantine Fast Olive Green EGLL

Original product of Ciba Limited Circular No. 714

Light Fastness	on cotton	6	6 -7	7
	on viscose rayon	6 7	7	7

Used for the production of many shades of green, either as a self colour or in combination with other Chlorantine Fast dyes. Dyeings show excellent fastness to light.

Chlorantine Fast Olive Green EGLL

levels well

reserves acetate rayon effect threads

yields the same shade on cotton and viscose rayon and withstands crease-resist finishing

An aftertreatment with

Lyofix SB conc. or Lyofix EW

improves the fastness to wet treatments

Fungicides and Bactericides for the Leather Industry

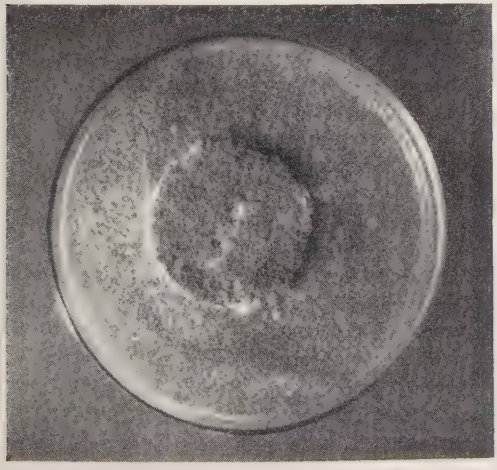
As described on page 3600, visible damage to the finished leather can be caused by parasitic attack at various stages. Causes can be diseases suffered by the living animal, attack on raw hides by micro-organisms before and during initial processing, and attack during and after tanning. Naturally, micro-organisms attacking the substance at any one of these stages can be re-activated at a later stage. In general, raw hides, skins, pelts, crust leather, and finished leather, no matter at what stage of processing, are exposed to the danger of microbe attack, provided the interplay of temperature, humidity, and pH favours growth. This applies to the following operations: conservation of the raw hides, soaking, liming, bating, pickling, tanning, storing of the shaved hides, dyeing and fatliquoring, airing and drying, and laying in sawdust previous to staking. Attack may also occur if the air in storage rooms has a high moisture content.

The nature and effect of micro-organic attack clearly show that their control calls for products with both a bactericidal and a fungicidal action. Depending on the operation involved, appropriate use is made of preparations affecting bacteria rather than fungi and vice versa.

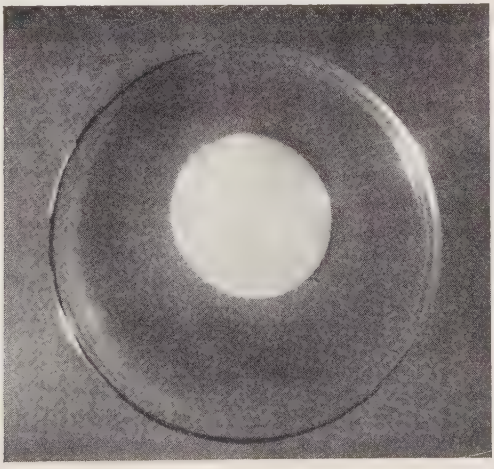
Three products meeting this requirement are discussed below. These comprise two water-soluble brands, Fungicide WK high conc., which is mainly bactericidal in character, and Fungicide G Paste with a pronounced fungicidal effect, and, third, for leathers with a high fat content, Fungicide L, which is soluble in organic solvents, fats, and oils.

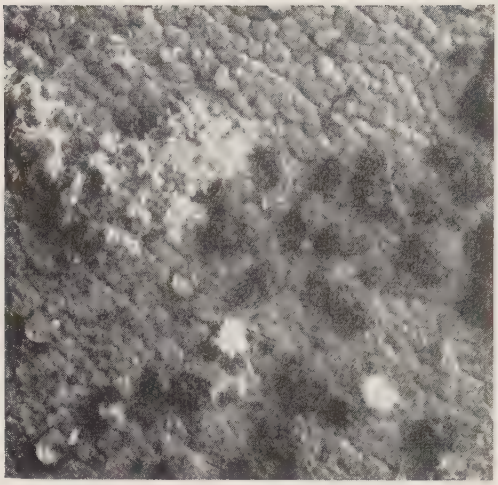
Fungicide WK high conc. is colourless, readily soluble in water, and stable to acids, alkalis, and common salt. Owing to its bactericidal action it is mainly used in soak and lime liquors. An essential advantage of Fungicide WK high conc. is its freedom from

Leather sample hand-stuffed without addition of Fungicide L. Pure culture test with Aspergillus niger. Profuse growth of the mould shows after four weeks.



Leather sample hand-stuffed with addition of Fungicide L. Pure culture test with Aspergillus niger. No fungi after four weeks.





Leather sample stuffed in the drum without addition of Fungicide L, and stored in tropical chamber. Heavy mould attack is seen four weeks later.

Leather sample stuffed in the drum with addition of Fungicide L, and stored in tropical chamber. After four weeks sample still shows no signs of mould growth.

tanning or protein fixing properties, as it causes no modification of the raw hides previous to tanning. The preparation is highly effective; amounts of as little as 210–350 grains/100 gal. (30–50 g. per cu. m.) in the soak or lime liquor are sufficient to check microbial action. For salted stock the wetting power of Fungicide WK high conc. is fully adequate. For soaking dried hides and skins, however, additional use of a non-ionic wetting agent is advisable so as to obtain a more rapid uptake of water and consequent shortening of soaking time. For this purpose Invadine* JFC conc. is recommended, a liquid readily diluted with water. 3–6 oz./100 gal. (200–400 g. per cu. m.) added to the liquor effect rapid and thorough wetting of the raw hides and skins.

Fungicide G Paste is a yellowish brown product readily soluble in water. Solutions are stable to alkalis, calcium, and magnesium salts but are precipitated by strong acids. Fungicide G Paste not only offers a high degree of protection against mould fungus and yeasts, but also possesses marked bactericidal properties. Therefore, apart from its application in soaking and liming, it is also used during tanning—especially vegetable tanning—and for aftertreating freshly tanned leather. The amount required for tanning, soak, and lime liquors is $\frac{1}{2}$–1 lb. per 100 gal. (0.5–1 kg. per cu. m.) liquor, and for aftertreating leather 0.3–1% calculated on the shaved weight.

Fungicide G Paste can be added to tanning extracts without losing its effect during storage or when diluted. 6 lb. per 100 gal. (6 g./l.) are quite sufficient for a 42° Tw. (25° Bé.) extract solution. The solution should be well stirred before further diluting.

In the case of pronounced mildew formation it is advisable to thoroughly clean tanning pits, paddles, and drums and then rinse with a Fungicide G Paste solution, a concentration of $6\frac{1}{2}$ oz. per 10 gal. (4 lb. per 100 gal. or 4 g./l.) being sufficient for this purpose.

Fungicide G Paste can also be used to protect glue, casein, albumen, mucilage, tragacanth, starch, and dextrin seasonings from mildew, fermentation, and putrefaction. 1–2% Fungicide G Paste, on the dry weight of the substance to be preserved, is used according to the temperature and required time of preservation.

Fungicide L is a dark-brown oily solution insoluble in water but soluble in organic solvents, fats, and oils. In addition to affording a high degree of protection against fungal attack, Fungicide L possesses marked bactericidal properties.

Fungi are apt to appear in large masses on curried leathers where they break down fats

and oils into glycerine and free fatty acids, which latter occasionally give rise to spews on the grain. However, bacteria present in the fats and oils may also be involved in the case of curried leathers and the combined action of fungi and bacteria often proves more harmful than that of either group of organisms alone. Attack is specially liable to occur on chrome vegetable-tanned leather such as waterproof for sports shoes and army boots. An oil and fat soluble agent such as Fungicide L is clearly required to prevent the growth of fungi and bacteria in such heavily stuffed leathers. It possesses two distinct advantages over water-soluble products: first, it is applied during currying, no separate operation being necessary; second, as a water-insoluble compound it is far more suited to the specific requirements of such leathers.

Fungicide L is mainly used for upper leathers such as those of sports and army boots, and also for harness and strap leathers.

Fungicide L is stirred into the molten grease mixture while this is still hot. This mixture is then applied to the leather in the hot air drum. The amount of Fungicide L to be used depends on the amount of grease to be incorporated. Calculated on the amount of grease applied, the following are appropriate percentages of Fungicide L: —

with 10% grease	8 % Fungicide L
with 15% grease	5.5% Fungicide L
with 20% grease	4 % Fungicide L
with 25% grease	3.5% Fungicide L

For leathers which are to receive a lower amount, the proportion of Fungicide L is raised accordingly. It goes without saying that the product may be added to animal and mineral oils used for oiling off leather previous to drying. This gives complete protection against mould formation during the drying process.

Besides its use in the processing of leather, Fungicide L is of value as an addition to leather oils and dubbins. After cleaning, leather articles may thus be given renewed and complete protection against fungal attack. This is an essential point in the storage of, say, military equipment.

If Fungicide L is used for oiling off purposes or to preserve leather oils and dubbins, 4% on the weight of substance used will be found sufficient.

J. Herndl

Fungicide G Paste in the Textile and Paper Industries

In addition to its numerous applications in the leather industry, Fungicide G Paste is successfully used in all branches of the textile and paper industries as a powerful agent for the prevention of fungal and bacterial attack.

In the textile industry its uses include the preservation of sizes and finishing mixes for yarns and fabrics, and of finished or unfinished textiles, printing pastes, and proofings.

The paper manufacturing and consuming industries employ Fungicide G Paste for preserving the "stuff", the finishing agents which are to be added to the pulp, and the glue for board.

When used as a preservative for textiles and paper the amount of Fungicide G Paste required is 1–2% (on the dry weight of the goods).

If, however, it is only required to protect textiles from mildew attack during manufacture 3–4‰ Fungicide G Paste is sufficient.

Finishing mixes require an addition of 1–2% Fungicide G Paste, calculated on the amount of finishing agent used.

Fungicide G Paste is also suitable as a general disinfectant for floors and walls, etc., in factories, and as an algae preventative for water.

Dyehouse Laboratories of Ciba Limited

Marking off in Printing

An article in Ciba Review No. 91 describes how Ciba* Scarlet G extra can be prevented from marking off during washing. It has been recently established, however, that Neovadine* AN offers a much simpler method of overcoming this disadvantage.

As is well known, marking off occurs when the dyestuff is in the reduced state; during rinsing the loose colour is washed off and stains the adjacent material. This can be prevented by adding Neovadine AN to the rinse water or to the oxidation bath. The Neovadine AN combines with the loose colour to form a water-soluble lake which has no affinity for the fibre and which can be readily washed out. This product is applied as follows:

Continuous method

Immediately after steaming the goods are treated on the mangle at room temperature with

2 g./l. Neovadine AN

and then given an air passage of 20 seconds, followed by a run through a bath containing

2 g./l. perborate and

2 c.c./l. acetic acid 40%.

After this treatment the goods are given a hot rinse, soaped at the boil, and finally rinsed again, first hot and then cold.

Winch method

After steaming, the goods are treated on the winch at room temperature with

1 g./l. Neovadine AN

and then oxidized with

2 g./l. perborate and

2 c.c./l. acetic acid 40%.

A third method is to add the Neovadine AN to the oxidation bath. The steamed goods are entered into the bath, at 105–120° F. (40–50° C.), containing

1 g./l. Neovadine AN

2 g./l. perborate and

2 c.c./l. acetic acid 40%.

Exceptionally clear white grounds are obtained by this method.

With the assistance of Neovadine AN the printer is now able to use Ciba Scarlet G extra —a colour of exceptional brilliance—without fear of encountering difficulties.

F. Reichart

New Ciba Dyes and Textile Chemicals

Specially recommended for	Brand name	Remarks
Dyeing acetate rayon, nylon, Perlon, Grilon; direct prints on acetate rayon	CIBACET BLUE F3R Circular No. 704	Good all-round fastness, reserves cotton and viscose rayon effects
Dyeing cotton and regenerated cellulose rayon for furnishing styles, knitted goods, dress materials, and fabrics to be subjected to crease-resist treatment	CHLORANTINE FAST OLIVE GREEN EGLL Circular No. 714	Very good fastness to light and levels well. Withstands crease-resist finishing
For all types of direct printing; as an outline black, discharges, and as a grey resist under Aniline Black	CIBA PRINTING BLACK TL(℗) MICRO PASTE Circular No. 692	Yields full blacks and neutral greys of very good all-round fastness
Use in the textile, paper, and leather industries	FUNGICIDE G PASTE Circular No. 2103	Highly effective preservative

Ciba's registered trade marks are given an asterisk on their first mention in each article of this series. - Information concerning the availability of Ciba products can be obtained from the nearest Sales Office or Representative.

PUBLISHED BY CIBA LIMITED, BASLE, SWITZERLAND E

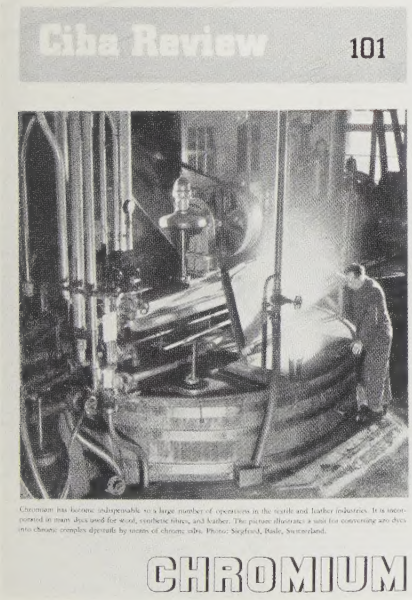
3620 Printed in Switzerland

Cibalan Dyes

for Polyamide Fibres

Nylon, Perlon, Grilon

No blocking	when producing combination shades
No saturation value	increased concentration gives increased depth
Very high fastness	high light fastness even in pale shades



Ciba Review No. 101

will appear in December 1953

and deal with

"Chromium"

Cibalan Dyes are eminently suitable for Wool Carpets – especially fitted carpets – on account of their excellent fastness to light and very good fastness to washing, alkali, peroxide bleaching, and chlorine.